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Concepts in SCIENCE

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Part One: CONCEPTS IN SCIENCE SERIES

The Teaching of Science

Third-grade children were seated in the school yard. With delight they watched the teacher as she draped a sheet about herself. Said the teacher, "Let's make of the sheet a fog and let's make of me a ship. The fog is now all around me, and I cannot see where I'm going. Just the same, this ship is not going to get lost. It will find its way to the northwest corner of the yard." And she made her way there, blinded. The children grinned and applauded. Several of them, proud and impatient with the possession of their knowledge, immediately offered to explain how the trick was done. "You have a compass," they said. Others were merely content to argue that the teacher could see through the sheet. The sheet was draped over a couple of unbelievers, who then accepted that the answer had to be a compass. It was.

How does a compass work? The children returned to the classroom, which was now a laboratory. There, during the course of a number of days, they examined compasses, investigated the work performed by magnets, and in the end, made crude compasses of their own. At one point, the teacher took a comb, rubbed it on her sleeve, and proceeded to pick up pieces of paper with it. Was the comb a magnet? Why? Why not? The children tested their understanding. They collected and recorded data. They used books to check their observations. They interpreted their data and exchanged views of their interpretations. They were, in short, engaged in the processes of science. They were also engaged, as we shall see, in the process of concept-seeking and concept-forming.

Now, none of what was done in this school yard and classroom will seem unusual to the imaginative teacher. What is of consequence to teachers and curriculum makers (and writers) is that such experiences should not become merely isolated parts of teaching science, that indeed, in the teaching of science, there should be a structure that is sound in itself. What the teacher was doing with the compass in the school yard and in the classroom was to use technology (in this instance, compasses and magnets) to create a situation through which children discovered concepts of science. We prefer to say that a good teaching program *uncovers* the concepts of science. Piaget's classical statement on this subject amounts, eventually, to this: the teacher creates situations through which children discover structure. By "structure" he meant relationships or likenesses among objects and events. A concept is a grouping of relationships, of likenesses, which explains objects and events in the world about us. Each of us tends to uncover the relationship at some particular time, but of course the relationship had been operating in the world before we came on the scene. A concept is new only to scientists, or to us, or to the children. The teacher's art lies precisely in the creating of situations through which children uncover concepts. This appears to be a plain and clear prescription, but of course there are some extremely complex problems confronting the teacher.

There is, obviously, the weight of the teacher's responsibility in teaching science today. In the second half of the twentieth century, children are born in a science-oriented

world, in a culture that puts an extraordinary premium on scientific thought and on scientific production. It is sensible to predict that most jobs in the future, including that of teaching, will call for scientific orientation of one degree or another. Contemporary-minded teachers must teach science because society demands it. Helping children to undertake a progressively more sophisticated intellectual activity is a central function in teaching, and creating productive situations—that is, the learning environment—is the teacher's day-to-day responsibility. It is, in many respects, an awesome one. Which situations—of all the countless ones that might be created—is the teacher to select? How is she to cope with the incredible diversity of scientific information, and indeed, with the diversity of children themselves?

From the time children are born, they watch, smell, feel, and listen: they are sentient to the objects and processes of the world. What they know largely derives from their senses and from their perceptions and from the number and kinds of experiences they have had. They acquire meaning, whether true or false, from many kinds of experience—in the classroom, in backyard play, in the streets, in the kitchen, in solitary reflection. They ask questions and examine things and ask still more questions. Because among individuals sensory perception varies and because human experiences vary in both kind and number, no two children begin school with the same knowledge, or with the same set of experiences. It cannot be presumed, therefore, that within the school framework they will move with equal speed or along precisely similar lines of growth. Some kind of provision has to be made to accommodate children of varying experience and of varying ability, and that provision is not alone concerned with the broader questions of homogeneous grouping in schools or of an ungraded curriculum; it is also concerned with providing a scientifically sound structure of learning and teaching science that enables children to uncover the concepts of science in an orderly (though not overly prescriptive) way and at a pace of their individual competency.

A structure in the teaching of science is needed not only to accommodate the phenomenon of diversity in children but also to manage the diversity of the content of science. Scientific research papers are currently being published at the rate of 67,000 words a minute! That amounts to a body of information that would fill eleven sets of a thirty-volume encyclopedia every twenty-four hours. Quite obviously, unless an attempt is made to evaluate, to select, and to sort new information into some kind of structure for the classroom, teachers will fall further and further behind. There is, moveover, the necessity to recognize that scientific knowledge, while it proceeds from facts, is not in itself the mastery of facts. Facts become meaningful, and the awareness of facts ultimately becomes productive, when they are perceived within the structure of basic concepts. We may modify George Gaylord Simpson's definition of science slightly. *Science is the exploration of the material universe for the purpose of seeking orderly explanations of objects and events, explanations that must be testable.* The products of science—which are its orderly explanations and the technology that results from the particular application of them—are the results of certain processes. The processes comprise the observation and examination of data including experimentation, the formulation of explanations by means of inventing hypotheses and stating theories, and the testing of the explanations. But the product of all this, the explanations, leads inevitably to other explorations and still other explanations. There are ends in science, but there is no end to science itself.

In their activity, scientists engage in concept-seeking and in concept-forming, and as a matter of course, in concept-testing. This is clearly a function of scientific inquiry. But what do children do when they are engaged in scientific activity? They explore the material universe (observe a plant grow, observe an object move down an inclined plane, observe a balloon that has been untied shoot through the air) and they seek orderly explanations of the objects and events they observe. They also investigate, and where possible, they might even experiment (although in a school context it is most difficult for students to perform an experiment in the *pure* sense simply because all the variables are difficult to control). They verify the data obtained from observations and they seek to interpret the data. They seek to predict results on the basis of the knowledge they have gained. They attempt to uncover explanations that reliably relate seemingly disparate or "discrepant" objects and events, and that will make prediction of other events possible. They, too, are engaged in understanding concepts of science and in applying them to the world about them.

Identifying the basic concepts of science is not the discrete task of the teacher. The teacher has the right to expect that she will be given help in identifying concepts and in forming a structure for the teaching of science, and this is a shared responsibility that the Concepts in Science authors and publisher, and the scientists and teachers who have advised them, have accepted. They recognize that school is time-binding, that work goes on in a certain time span—grades, terms, years—and that many teachers share in the development of each child. They know that a teacher must have a notion of what school experiences children have had before they come into her ken, as well as what will follow once they leave her. The need for a curriculum in science which gives the teacher scope and flexibility is plain enough; what is sometimes not so plain is the need for a curriculum that has a scientifically sound and pedagogically sound structure. We have attempted to give structure to the teaching of science during the first nine years of schooling by informing the processes of science with an understanding of the concepts of science. We have, in short, sought to identify and define a structure that is not only verifiable scientifically but also viable (practical, productive) in teaching children. The conceptual approach is central, in our view, to both aims, both to sound science and sound teaching.

A Modern Science Curriculum

Early in the twentieth century the school curriculum in the United States tended to be content-centered, or disciplinary. During the twenties and thirties this curricular approach gave way to a so-called child-centered approach; the emphasis was shifted—this is overstated for purposes of simplification—from the subject to the learner. Today, still another shift is occurring as content is being placed in a stronger and more relevant role in the curriculum. More and more the emphasis is placed on the interrelationship, more specifically the interaction, between the discipline and the pupil in the learning act. Again with some oversimplification, the contemporary curriculum can be said to be process-centered. Certainly this is apparent in science teaching, and the advance of this kind of curriculum has been most directly aided by the involvement of scientists in the elementary and secondary schools. They have been enormously helpful in proposing a teaching structure for the early school years of science study.

Within the various disciplines of science—biology, chemistry, physics, geology, etc.—data accumulates and changes at a bewildering rate. Change is constant. Yet the concepts of science—which are a patterning of facts and the statements of the relationships between observable events and objects—are relatively stable. In a changing world, concepts offer, for this and other reasons, a reasonable foundation for the building of a science curriculum. They are, in a true sense, guides as well as aids to learning.

All of us have the task of sorting out events that come to our awareness in haphazard sequence. All of us have the task of discovering which of the objects and events we perceive are significant and which are not. To bring order out of our haphazard perceptions, we tend to seek a grouping of likenesses among a number of objects and events perceived; in short, we tend to seek concepts. To form a concept, we assort or group objects and events according to their attributes and properties, and we define categories. An example of what is meant by the "attributes" of an object or event will be useful.

A stone has shape, color, weight, and the like; these are some of the attributes of a stone. A bird also has shape, color, weight. Yet there are other attributes of the stone—for example, immobility and hardness which we recognize as part and parcel of "stoneness." A bird, on the other hand, has mobility, it has feathers, it has egg-laying propensities, and it has a certain structure (from beak to tail)—these and other attributes we recognize as essential to "birdness." In forming a concept, the brain selects those essential attributes (those which discriminate one object from another) which signal the whole configuration of the object or event. Thus the weight of an object is generally not an essential or discriminatory attribute; an attribute of a weight of one pound might apply to a one-pound chicken or a one-pound stone. But "feather" or "beak" is a signal, or cue, for categorizing or concept-forming. It is a signal of the whole concept of "birdness" and it enables us to fill in certain other essential attributes.

Now in learning, the *act of concept-forming* enables an individual to infer; from a few signals or cues he can infer a significant grouping, or category, of like attributes. These signs or cues can be related to *objects* (stones, birds, simple machines) or to *events*, such as the changing of one form of energy to another (for example, the friction of the hands resulting in heat, or the reproduction of organisms, or the splitting of an atom). A specific example in the teaching of a concept, in developing the ability in children to group the like attributes of an event, can be given here. Suppose we wished to create situations through which children would uncover the events that can be grouped within the concept: *Organisms (living things) reproduce their own kind.* This is precisely the objective of Unit Eight in *Concepts in Science 1.* A series of fifteen lessons is organized in a sequence in which situations are created whereby children come to *associate* an entire set of attributes of this event: *organisms reproduce their own kind.* Even if children were to undertake the analysis of only the four problem-picture situations shown, they would be engaging in the selection of essential

Find the parent.

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attributes of the event. This would enable them, in turn, to predict the event from one signal, say an egg. But the text suggests activity after activity—insect eggs are collected, chicken eggs are allowed to hatch, bird's nests are observed, fish are bred in an aquarium, the relationship of adult to young (dog to puppies, cat to kittens) is observed and analyzed. Perhaps you would care to examine Unit Eight now for a fuller exposition of the way the text assists the teacher in creating situations through which children engage in concept-seeking and concept-formation. But, of course, the text is only part of a very rich program of science in which process is central (see page T–10).

In brief definition, then, *a concept is a mental construct; it is a grouping of the common elements or attributes shared by certain objects and events.* Once a concept is attained, economy in future learning is also attained. For by engaging in the processes of concept-formation, the learner is active in selecting the essential attributes of the complete event, such as "organisms reproduce their own kind." And the learner is enabled to predict an entire sequence of events, or an entire set of characteristics or properties, from a small number of cues or signs. Thus a bird's egg, or an insect's cocoon, is a cue signalizing an entire event.

Defined in other words, a concept is a network of inferences stemming from observation of objects and events, resulting in the selection of common elements, or like attributes, among the objects and events under observation. Identifying and organizing the common, or like, attributes result in a significant category or grouping. That significant category is a concept. A concept is practical and useful because the perception of a small number of attributes, cues, or signals, brings the whole object or event into satisfying recognition. To repeat, an egg brings to mind the object (the bird) and the event (reproduction).

Because we are teaching small children, it is well to *group* experiences in a way which will enable teachers to plan their work sequentially. Hence we have ordered the *concept structure of the curriculum you have in hand.* It provides for small blocks of experiences, dealing with objects and events with similar attributes which young children can handle. We have attempted, moreover, to develop a curricular structure which bears some correspondence to the school year, day, and period. Further, for purposes of readier facility in planning the work of the first six years of elementary school, we have grouped a given series of concepts under a still larger category which we call a *conceptual scheme.*

A study of Unit Eight in *Concepts in Science 1* will show that while the unit is built around a *concept*, each lesson is built around a subordering of the concept, identified as a *subconcept.* Thus (p. 76)

Concept for Unit 8:
Organisms (living things) reproduce their own kind.
Subconcept Lessons 1, 2, 3:
Some animals reproduce their own kind through eggs laid externally (a study of reproduction of birds, reptiles, insects).
Subconcept Lesson 4:
Some animals pass through a cycle of change from egg to adult (a study of changes during the life cycle in the moth).

Note that the concept for Unit 8 is the first of a series of six concepts subsumed under a conceptual scheme: *Organisms are the product of their heredity and their environment.*

Find the parent.

Find the parent.

Conceptual schemes provide, we believe, a framework within which the teacher can provide experiences that will lead students to participate in the processes of science—in observation and in interpretation—and emerge with the products of sciences, which are testable explanations of the workings of the material world. This seems to be a large order. It is. The authors and publisher have spent eight years in the preparation of the curricular organization and materials in this program. They have tested its performance during hundreds of hours in typical classrooms. It is their belief that the conceptual approach is a feasible one that will produce excellent results. In an ultimate sense, their aim is to help the teacher produce an interaction between discipline and student, between the subject and the learner. For this reason, content is never skimped. For each grade there is a hard core of content or subject matter that exceeds more than even the bright child will be able to encompass in the time he is generally allowed.

What has been done in this program, then, is to lay out a framework of conceptual schemes through the first six years of schooling. The framework is capacious. It does not fix the teacher or the student into an inflexible curriculum. On the contrary, it gives the teacher freedom to plan a variety of experiences and it gives the student freedom to plot his own experiences. In both instances, however, the experiences will be ones which are relevant to a search for meaning rather than for the random acquisition of facts. In a real sense, understanding is made simpler for children when they are able to conceptualize—to see patterns in their environment, to group objects and events on the basis of their common elements. A program that accomplishes this is essentially an economical one, economical in the time that is spent in learning. Because, as has been said earlier, concepts remain relatively stable, concepts provide an organization of information that is itself relatively stable. New observations, new data, variant experiences can all be fitted into the conceptual framework.*

Teachers in St. Mary's County, Maryland, have been experimenting successfully with an elementary science curriculum based on conceptual schemes. Their course of study, initially developed by a curriculum committee, is now in its sixth year of development. Similar courses of study have been developed by other schools and school systems, particularly the Nova School, Fort Lauderdale, Florida.

If we interpret the psychology of learning with any degree of acuity, then we assume that it is important for children to learn in "wholes." In this sense, concepts are "wholes." Moreover, if we accept the definition that education should result in a change of behavior in the student, then an understanding of concepts will provide a person with intelligent means of deciding among alternatives. The conservation of natural resources; the support of public health programs; the questions of population growth; the fallacies in ethnic discrimination—all these are civic and social matters that confront a contemporary person. He is better able to judge what he perceives, and better able to support what he believes, when he understands the basic scientific concepts. The teaching of science ought to do more than dispel ignorance and superstition; it ought to help provide means by which a human being can comprehend what is today known but still unseen or still not widely operative. Exploration of the moon is a certainty, even though it has not yet happened.

The *Concepts in Science* series is an elementary science curriculum which attempts to reflect commonly accepted and basic ideas of contemporary scientists, cognitive psychologists, and teachers. It is a systematic organization of instructional materials. It is also a laboratory-centered program. The framework of six conceptual schemes provides a learning sequence that is shown, in broad outline, on the chart on pages T–8 and T–9. The sequential development is represented on the chart as horizontal threads called *concept levels*, which increase in complexity as one advances from one level to the next.

The National Science Teachers Association Committee on curriculum development, in "Theory in Action," † suggests seven conceptual schemes. The Committee agrees upon twelve statements. Seven of these statements discuss conceptual schemes, and five of them describe the process of science as the base for science curriculum planning. In the *Concepts in Science* series, the concepts have been grouped under six conceptual schemes, but the differences between this organization and that of "Theory in Action" is not substantial or finally consequential. The authors suggest that the content of the science curriculum could be arranged in an orderly structure under six conceptual schemes in a way that effects economy in organization, time, and effort.

* For a fuller explanation of concept-seeking and concept-forming see "Experience in Search of Meaning: A Reasonable Approach to the Teaching of Elementary Science" (to be published).

See also *A Study of Thinking* by Jerome S. Bruner, Jacqueline J. Goodnow, George A. Austin, John Wiley & Sons, Inc., New York, 1956.

† Published by the National Science Teachers Association, 1964.

A Comprehensive Program

The major conceptual schemes can be stated in somewhat arbitrary terms; no doubt, different teachers will state them differently. Certainly they would be stated differently for the scientist-specialist than for the elementary-school teacher, who of necessity teaches not only science but English and social studies. Certainly the statements may be modified and restated under different conditions, with different students and in different schools. Yet the authors have chosen to state the conceptual schemes in terms that can be used throughout the particular content and activities in the *Concepts in Science* program.

A Framework of Conceptual Schemes

The conceptual schemes and the general areas they subtend are:

1. When energy changes from one form to another, the total amount of energy remains unchanged.

Energy transformation is a common phenomenon. If you rub your hands, mechanical energy is converted to heat energy. If you burn a candle, chemical energy is converted to heat and light; and in a dry cell, chemical energy can be converted to electric energy. But whether one is concerned with burning oil in the home, gasoline in the automobile, glucose in the body, or whether one is concerned with the transfer of the energy of moving water into a flow of electrons in a conductor, the total amount of energy in any given system remains the same. This conceptual scheme is a primary concern in the discipline of physics.

2. When matter changes from one form to another, the total amount of matter remains unchanged.

The world of matter consists of a world of things, from the very large bodies—stars, planets, moons, and other celestial bodies—to the very small particles—atoms, molecules, and subatomic particles. As the matter in the universe undergoes physical change, a change of state, and chemical change, a change in form, the total amount of matter undergoing chemical or physical change in any given system remains the same. This conceptual scheme is treated within the discipline of chemistry.

3. Living things are interdependent with one another and with their environment.

Around living things everywhere, there exists an environment of matter and energy; indeed, living things cannot be considered apart from their environment. Plants depend upon their environment for their growth and development. Green plants capture energy from the Sun in the photosynthetic process; animals, in turn, transform the chemical energy of plants. And finally, all plants and animals yield their matter and energy as they die and decay. In addition, the demands of living in a given environment result in a relationship between plants and animals in communities that display definite characteristics—deserts, forests, seas, ponds, etc. For example, the sea is an environment in which ninety percent of the world's photosynthesis takes place, where complex food niches are developed, and intricate reproductive cycles operate. Understanding these interrelationships results in our ability to predict, within limits, the behavior and development of plants and animals. The conceptual scheme that describes them is a part of the study of biology.

4. A living thing is the product of its heredity and environment.

Within this conceptual scheme, one can develop the concept of an organism that lives in a kind of dynamic equilibrium. The organism is never the result purely of its heredity but of the environment interacting with hereditary factors. This is true of any specific trait. This is also important to comprehend in a human being's realization of full physical development and vigorous health. Other examples:

A red barberry is greenish unless exposed to strong sunlight.
An intelligent child needs an education.
Beets in acid soil are stunted.
A child lacking vitamin B may develop beriberi.
A potato seedling in the dark is attenuated.
A child poorly fed and poorly housed does not resist tuberculosis as well as one who lives in a more salutary environment.

The full range of the development of organisms—including the study of reproduction, genetics, growth, nutrition, behavior, and adaption to the environment—is involved in this conceptual scheme, which is the concern of several sciences: genetics, physiology, and biochemistry.

5. Living things are in constant change.

The universe changes; the Earth changes; the single organism and the species change over the ages. The concepts of adaptation over the ages, divergence in form, convergence in geographical isolation, and evolution are within the purview of this conceptual scheme, which involves genetics and ecology.

6. The universe is in constant change.

Every child today seems to know that the solar system is changing. Certainly the Earth's atmosphere is constantly shifting. The Earth is in constant motion; the Sun is in constant eruption. We note the appearance of novae and

supernovae. We observe and gain evidence from Cepheid variables. We interpret the red shift in starlight to indicate an expanding universe in constant change. The change in the universe comprises a conceptual scheme that is the primary concern of geology, astronomy, and meteorology

A Developmental Structure of Concepts

Expectedly, as the concepts in science are selected to fit the purposes of instruction in the elementary school, they seem to group themselves easily. The rationale is this: first, concepts should fall easily into a particular conceptual scheme; second, they should be ordered from the simple to the complex. "Simple" is used here in the sense that the experiences provided should be simple. Young children do not deal with a complexity of cause and effect, that is, with *multiple variables*. For example, it is fairly easy in the early grades or levels to deal with the concept *plants and animals reproduce their own kind*. On the other hand, the concept *the characteristics of a living thing are laid down in a genetic code* requires that we make available more complex experiences which are appropriate at higher levels. All this is not to imply that some children cannot deal with more complex structures even while the norm for a class is said to be a concept development at a lower level. A particular advantage of a conceptual structure in the curriculum is the provision for extended or accelerated growth in individual children. For instance, if a child seems to understand a concept at a higher level of complexity than his classmates, the teacher can determine the level of understanding by asking appropriate questions at a lower concept level (as indicated by the chart on pages T-8 and T-9). If there is a sufficient number of children who are able to deal with a higher concept level, procedures may then be modified.

The organization of a curriculum in terms of concept levels accommodates its own "multiple tracking." As a result, it is possible to have groups, or even individuals within the same class, proceed at different rates up the concept "rungs" of the conceptual "ladder." They can engage in experiences which are appropriate to their level of understanding, and at the same time communicate with groups at other concept levels. In other words, they are all on the same ladder, if on different rungs. In any event, a teacher will certainly wish to know the entire conceptual structure. You will find the structure for *Concepts in Science 1–6* in the chart on pages T-8 and T-9.

The concepts which form the rungs of the conceptual ladder can be stated in various ways, but the central purpose is to organize them in graduated order so that understanding of one (in a lower level) precedes the next for purposes of greater comprehension and utilization. There is some danger, we believe, in stating a conceptual scheme (or even a concept) by a single term (for example, *energy, matter, life*). However convenient this may seem, such easy rubrics may have the effect of limiting the implications of this approach to science study.

Now, the structure for science in the first six grades of the elementary school, here given as six conceptual schemes, with the concepts given at six levels (not necessarily grades), is purely for convenience and custom. The levels, until research proves this unwise, are in a rough order of precedence. Naturally, each concept has a number of subconcepts; the development of subconcepts depends on the judgment of the teacher.

The essence of science is *investigation of the material universe*. Its goals consist of a search for meaning; indeed Albert Einstein once defined it as experience in search of meaning; it *seeks orderly explanations (conceptualizations) of phenomena, the objects and events about us*. Nevertheless, there is stubborn insistence by scientists that an orderly explanation *be testable*. If a concept is not testable, it is usually not acceptable. Science is, in short, the "art of investigation" (Beveridge's term). But one cannot investigate an object or event if the object or event is not first perceived.

This book is literally a sourcebook of situations in which children participate and perceive objects and events. In creating a learning situation, children are given opportunity to seek the attributes of objects and events and to seek hidden likenesses. In the situation described on page T-1, the third-grade children engaged in these processes: they *observed* the working of a compass; they *investigated* the relationship between magnets and compasses; they *collected* relevant data; they *described* the operation of the magnet; they *discussed* their results; they *confirmed* one another's results (through collaborating in an investigation); they *read* the work of scientists; they *reported* their results in kind of colloquium. Note the processes: observation, investigation, collection of relevant data, description of results, discussion of findings, confirmation of findings, reading the work of scientists, reporting of work, and within limits, experimentation, among others.

A Structure for

	CONCEPTUAL SCHEME A When energy changes from one form to another, the total amount of energy remains unchanged.	CONCEPTUAL SCHEME B When matter changes from one form to another, the total amount of matter remains unchanged.	CONCEPTUAL SCHEME C Living things are interdependent with one another and with their environment.
CONCEPT LEVEL VI	The amount of energy gotten out of a machine does not exceed the energy put into it.	In nuclear reactions, a loss of matter is a gain in energy; the sum of the matter and energy remains constant.	Living things are adapted by structure and function to their environment.
CONCEPT LEVEL V	Energy must be applied to produce an unbalanced force, resulting in motion or change of motion.	In chemical or physical changes, the total amount of matter remains unchanged.	The capture of radiant energy by green plants is basic to the growth and maintenance of all living things.
CONCEPT LEVEL IV	A loss or gain of energy affects molecular motion.	In chemical change, atoms react to produce change in the molecules.	Living things capture matter from the environment and return it to the environment.
CONCEPT LEVEL III	The Sun is the Earth's chief source of radiant energy.	Matter consists of atoms and molecules.	There are characteristic environments, each with their characteristic life.
CONCEPT LEVEL II	Energy can change from one form to another.	A change in the state of matter is determined by molecular motion.	Living things depend on their environment for the conditions of life.
CONCEPT LEVEL I	Energy must be used to set an object in motion. There are many forms of energy.	Matter commonly exists as solids, liquids, and gases.	Living things are affected by their environment.
	CONCEPTUAL SCHEME A When energy changes from one form to another, the total amount of energy remains unchanged.	CONCEPTUAL SCHEME B When matter changes from one form to another, the total amount of matter remains unchanged.	CONCEPTUAL SCHEME C Living things are interdependent with one another and with their environment.

Concepts in Science

CONCEPTUAL SCHEME D **A living thing is the product of its heredity and environment.**	CONCEPTUAL SCHEME E **Living things are in constant change.**	CONCEPTUAL SCHEME F **The universe is in constant change.**	
The characteristics of a living thing are laid down in a genetic code.	Changes in the genetic code produce changes in living things.	Nuclear reactions produce the radiant energy of stars, and consequent change.	CONCEPT LEVEL VI
The cell is the unit of structure and function; a living thing develops from a single cell.	Living things have changed over the ages.	Bodies in space (as well as their matter and energy) are in constant change.	CONCEPT LEVEL V
A living thing reproduces itself and develops in a given environment.	The environment is in constant change.	The motion and path of celestial bodies are predictable.	CONCEPT LEVEL IV
Living things are related through possession of common structure.	Living things grow and develop in different environments.	There are seasonal and annual changes within the solar system.	CONCEPT LEVEL III
Related living things reproduce in similar ways.	Forms of living things have become extinct.	There are regular movements of the Earth and Moon.	CONCEPT LEVEL II
Living things reproduce.	There are different forms of living things.	There are daily changes on Earth.	CONCEPT LEVEL I
CONCEPTUAL SCHEME D **A living thing is the product of its heredity and environment.**	CONCEPTUAL SCHEME E **Living things are in constant change.**	CONCEPTUAL SCHEME F **The universe is in constant change.**	

Resources for a Comprehensive Program

The structure of science and the processes of science yield knowledge and they yield understanding but at no time could they exist without the materials of science—materials which provide the media for investigation, whether the investigation involves reading a textbook or carrying out a sophisticated experiment in the laboratory. The materials for *Concepts in Science* include the facts of science as well as the tools of science. These materials come in the form of reading matter, illustrations, manipulative objects, laboratory guides, testing instruments, and other aids to teaching.

The *Concepts in Science* series provides the whole range of suitable materials for Grades 1–9. It includes basic textbooks for the child, each accompanied by a Teacher's Edition for Grades 1–6 (a separate Teacher's Manual for Grades 7–9); Workbooks for Grades 4–9; packaged equipment for Grades 1–6 called *Classroom Laboratory;* individual investigation cards called *Invitations to Investigation;* and *Teaching Tests*. There are, moreover, books available for the teacher.

TEXTBOOKS

Each book in the *Concepts in Science* series is organized to accomplish efficiency in the learning process. Each book is designed to create an atmosphere of discovery in concept development; to stimulate personal involvement; to maintain sharp curiosity; and to lay a firm basis for intelligent action and independent inquiry. The processes of science, as well as its products, are emphasized and yet interrelated as the student participates in the act of learning. Each book is illustrated for visual interpretation of objects and events that may or may not be a part of the pupil's everday experience.

While the full-color photographs and drawings enhance the visual quality of the textbooks, they serve the important function throughout the program of training children to observe with discrimination the pictorial representations of their physical environment. Many of the photographs are of actual performances by children and experienced teachers in the classroom.

Each book contains an abundance of investigations to help develop the main concept of a section. As the investigations are self-contained and self-explanatory, except in *Concepts in Science 1* and *2* where the directions are given by the teacher, little discussion of the investigations is given other than to suggest possible pitfalls and to advise on the most profitable time during the lesson to undertake the investigation. Actual photographs illustrate one trial investigation. Since the text does not tell what happens, the photographs serve as guides for the pupil; but the pupil must observe for himself and try the investigation. All of the investigations within the sections have been laboratory tested not only for effectiveness, but also for safety.

In addition to the investigations that are found at strategic points within the sections, there are "open-ended" investigations at the ends of the sections as well as at the ends of the units. Each investigation is an extension and addition to the pupil's initial concept formation. Furthermore, these additional investigations point up the fact that many trials are necessary to establish and confirm results of one investigation. End-of-book sections, which progress in difficulty from book to book, stimulate individual investigation that is relatively complex in observation and experience.

Each book in the *Concepts in Science* series features cumulative concept reviews and evaluations which enable the pupils to test their understanding of a concept. These reviews enable pupils, moreover, to apply their understanding to new situations, to hypothesize solutions to a variety of problems, to recognize relationships among concepts, and to infer relationships among conceptual schemes. At every step of the way the pupils are provided with experiences which help them find unity among diversity, to achieve order out of disorder in the objects and events of the world around them.

Concepts in Science builds a precise science vocabulary. Throughout the program, provision is made for growth in vocabulary as it specifically relates to science. In *Concepts in Science 1* and *2*, the teacher is encouraged to introduce new words on a science vocabulary chart to be displayed in the classroom. These same words are listed in the back of the child's text for his individual use. In Books 3 through 6, key words are introduced in boldface type and are repeated, with page references, in the glossary and index. Definitions in the glossaries increase in depth and variety of meaning from book to book.

The reading vocabulary has been carefully controlled for the grade level throughout the program, with due attention to the adequate presentation of technical vocabulary necessary to understanding concepts in science. In *Concepts in Science 3* and *4*, a pronunciation-at-sight system is used; and in the textbooks for *Concepts in Science 5* and *6*, a standard system of diacritical marking is used.

TEACHER'S EDITIONS

The Teacher's Editions to accompany the *Concepts in Science* textbooks are organized for maximum teaching effectiveness. They contain all the background information that teachers need to teach a unit with confidence and enthusiasm, which eliminates, for the most part, the necessity for further research on the part of the teacher. The conceptual structure of the curriculum is outlined clearly, and carefully selected activities and experiences are prescribed and described as effective means of concept development.

A comprehensive teaching pattern is apparent in each of the teacher's editions and is analyzed in detail in **Part Two** of the introductory material in each book. In this book, the analysis is found on pages T–14 and T–15.

CLASSROOM LABORATORY

The classroom for science should resemble a laboratory in which children actively work with objects at their own desks or tables, individually and in groups, observing, rearranging, manipulating, investigating, experimenting, testing, and discussing their findings and inferences with one another.

The *Classroom Laboratory* for the *Concepts in Science* series is a practical way of converting an ordinary classroom into a classroom laboratory. There is one each for *Concepts in Science 1–6* which is designed to fit the needs of the science curriculum by providing the materials and equipment for pupils to experience science in the classroom. It is built around the concepts of the science curriculum; it anticipates and solves the problems of classroom management, and is designed to be used by the entire class.

While an entirely optional part of the *Concepts in Science* program, the *Classroom Laboratory* deals with investigations that give pupils the opportunity to uncover the science concepts that are developed in the basic textbooks. The Teacher's Manual which accompanies the *Classroom Laboratory* is keyed by page number to the pupil's textbook. Thus, teachers know at exactly which point in a lesson it is most profitable to introduce an investigation.

Each *Classroom Laboratory* is accompanied by a Teacher's Manual. Pupil's instructions are supplied where necessary.

To provide opportunities for an entire class to experience the processes of science, the equipment and materials are supplied in multiples of six. A class of 30 pupils, for example, may be divided into six groups of five pupils, with each group performing the same investigation. There are also materials for the performance of numerous individual activities which may be used as teacher or committee demonstrations. Furthermore, the laboratory is so organized that it is possible to find any required material within a few moments and to return it easily to its proper place for future use.

While the contents of the individual laboratories differ, depending on grade level, each contains an assortment of commonly-used apparatus: beakers, test tubes, tripods, plastic tumblers, plastic dishes, and other basic materials, which can be reused whenever needed. With normal use, some depletion of parts will occur each year and a small portion of the items are consumable. Replacements are available from the publisher.

WORKBOOKS

Concepts in Science Workbooks, available for Grades 4 through 6, give pupils additional opportunity to reinforce and extend their understanding of the concepts developed in the *Concepts in Science* textbooks. Through the experiences that are provided in these workbooks, pupils review concepts and apply them in new context. New problems are introduced which are related to problems they have already studied, but which differ in some significant way from those in the textbooks. Moreover, the workbooks give additional practice in utilizing basic laboratory skills—recording observations, tabulating data, interpreting data, and drawing conclusions as well as practice in using scientific apparatus. The activities in the workbooks have been selected to provide experiences in various situations—at home, in the classroom, on a field trip, in the library, or in the laboratory; and from these experiences, pupils are called upon to organize and apply the concepts and skills initiated and developed in their textbooks. Self-testing reviews are included for additional pupil evaluation and a Teacher's Correction Key, separately available, provides suggested answers.

TESTS

Science *Teaching Tests*, prepared and screened by the Harcourt, Brace & World Science Testing Board, are available separately for *Concepts in Science 3* through *6*. The answer keys are found in the Teacher's Editions of the textbooks.

These tests, to be used after each unit in the pupil's books, go beyond the testing of facts. Like other elements in the *Concepts in Science* program, they help teachers evaluate the pupil's understanding of concepts. The questions for each test are designed to evaluate comprehension as well as retention of information. They are divided into several parts; the parts, depending on the sophistication of the concept level, are designed to test the child's ability to read for comprehension and interpretation; the ability to recall factual information; the ability to evaluate and apply concepts in new situations. They may also determine how well the pupils perceive relationships among the concepts developed. The pages in the test booklets may be assigned individually or for the entire class.

LABORATORY CARDS

100 Invitations to Investigate, a set of 100 ungraded laboratory cards, provide the background information, illustrations, and clues to procedure for pupils' independent investigations. The investigations are a random assortment in the biological, physical, and chemical sciences and progress in difficulty—the higher numbered investigations being more sophisticated. The cards, which are packaged in a sturdy case, are designed for those pupils who wish to pursue, beyond what is covered in the textbook, their own interest in some particular area of science, independent of their regular classroom work. Each child is encouraged to select the investigation in which he is interested, to investigate with enthusiasm and imagination, to seek answers to problems for which his textbook offers no solution. While designed for enrichment, the laboratory cards also lend themselves to the development of a science course for specially interested students and for science in ungraded programs.

SOURCEBOOKS FOR THE TEACHER

Harcourt, Brace & World publishes a number of outstanding professional books which provide supplementary information for teachers on how to plan, prepare for, and carry out a science program in the elementary school. Written by specialists in the field of science education, these books provide the "tactics and strategy" as well as the techniques for teaching elementary and high school science. They also employ the scientific and educational psychology involved in the teaching of science. You will find a list of these publications on the first page of this book.

Part Two: CONCEPTS IN SCIENCE 1

Structure and Content

Concepts in Science 1 is more than a series of related lessons. It is more than the sum of its separate parts. It is the first in a series of six books which comprise an elementary science curriculum. It is a fully sequential and articulated program in which each unit of work is dependent upon previous units already studied. Each lesson is part of a larger pattern, the section; each section is part of a still larger pattern, the unit. The unit, in turn, is part of a still larger pattern, the year's work in science.

Even a casual perusal of the two texts, the child's and the teacher's, reveals the developmental structure of the entire program. The earlier units, taught at the beginning of the school year, are shorter and more slowly paced than the units designed for later in the year. The same holds true for the first lesson in each unit. Each lesson depends on the lessons that have preceded it, and each unit builds on the units that have gone before.

Science vocabulary is cumulative. Energy, for instance, is introduced in Unit One in relation to motion. In later units, energy is reintroduced and reused in relation to evaporation, growth of plants, light from the Sun, and the development of the human body.

The conceptual schemes that are set forth in this teaching text and the concepts which serve them, lend themselves to basic experiences for children as they study the objects and events in the world around them. A concept learned in one unit is recalled and reapplied in new context in later units.

In *Concepts in Science 1*, the eleven units develop the first concept level of the six major conceptual schemes. Each unit is primarily concerned with one conceptual scheme, but in some cases there is an overlapping of schemes. The eleven units deal with a variety of subjects: motion, gravity, friction and wheels, clouds and precipitation, the rotation of the Earth, rockets and astronauts, plants from seeds, animals from eggs, growth of children, dinosaurs and fossils—to give but a partial list. Yet, to the scientist, these units are concerned with only three big categories: energy, matter, and life. These three categories may be studied at any age, in any grade, and at any level of sophistication in relation to what the authors have chosen to call the six major conceptual schemes—schemes which are basic to the child's understanding of the material universe.

Each conceptual scheme, treated at the first concept level, is basic to understanding the scheme as it is developed further at the second concept level. The conceptual schemes are not taught to the children; rather, they are the eventual goals which the learner will reach through experiences which have been selected to provide for the pupil a maximum of individual involvement in the learning process. It is a step-by-step process of concept formation throughout all the grades.

The exploration of the environment, certainly a major aim of science, does not begin in the first grade or even in kindergarten. Most young children enter school with a fund of science information (and misinformation) and a fairly well-developed pattern of behavior that has long served their need to satisfy their natural curiosity. They have had experiences, but experiences that have not always been planned in search of meaning. In school, the experiences are selected and organized in a search for meaning, for conceptual understanding.

In the first grade, teachers help children to organize and evaluate their information, and to use and improve their habits and skills of investigating. The investigating, however, is no longer the random process of early childhood, rather, it proceeds in a sequential, developmental pattern of lessons, thoughtfully and systematically organized as a science curriculum. Let us examine the pattern in *Concepts in Science 1*.

THE STRUCTURE OF A UNIT

All of the units in this text, both the child's and teacher's, have the same structure and the same component parts. It is useful to trace the development within a unit by sampling pages from this Teacher's Edition. For example, Unit One: "Making Things Move," page 1, reveals the orientation to the lessons in the unit—and similarly, to other units in the text. Unit One has been selected to illustrate the structure of a unit in which several concepts support a conceptual scheme.

THE PATTERN OF A LESSON

In each science lesson, the child has experiences that enable him to take one small, specific step toward the understanding of some important concept. After a number of lessons dealing with the same concept, the child gains in his understanding of that concept, even though he has never said or heard the concept stated in specific terms.

Like good lessons in other subjects, the daily lesson in science has three main parts:

the introduction—in which a problem is raised and curiosity is stimulated; that is, thought is linked to action

the main body of the lesson—in which the content is organized for concept development and then summarized

the reinforcement or extension of the lesson—in which a variety of activities are introduced for enrichment.

In the lessons, the children become aware of new relationships as they discover similarities among objects and events that previously may not have appeared to be related. Gradually, as the children recognize and understand some of the patterns of relationships in the universe, they build their concepts in science. The concepts evolve in the child's mind as specific steps toward understanding.

Each lesson is introduced by some activity that raises a question or poses a problem. Usually some object or objects are required for the activity. In classroom trials of the lessons in this text, it has been found that the materials listed add greatly to children's attentiveness and interest.

Once the lesson is introduced, the teacher may stimulate and guide children's curiosity by asking the pertinent questions found in bold-face type. The children are asked "Why?" To find out, they turn naturally to their science texts and continue with the main part of the lesson.

In *Concepts in Science 1*, it is not expected, especially at the beginning of the term, that children be able to read the sentences on the pages of their textbook. Even though an occasional class may be able to do so, it is suggested that first-grade teachers assume responsibility for reading the text as suggested here. Only the individual teacher can know at what point or to what degree, if any, children might participate in reading the text aloud to the class. Since comprehension of relationships leading to concept formation in science is the present goal, it is not desirable to have children puzzling and stumbling over words. When the sentences are read aloud by the teacher, first-grade children have no difficulty in comprehending the meanings. This procedure keeps the lesson moving forward at a good pace, holds the class together, and gives young children the security of the teacher in her proper leadership role.

Some of the important understandings that can come from a lesson are listed in brief statements. It is not expected that children will or should be able to express these ideas as they are expressed, or that every child, or even any child, will reach all of the understandings. Specific comprehension will vary naturally from class to class in relation to the mental maturity of the children. The main ideas are listed to serve as guide posts for the teacher, who, in her creative and intelligent way, will use them as she helps children to understand the concept according to their separate abilities.

Some of the activities, it will be noted, are appropriate as assignments or projects for individuals or small groups. Some are suitable for broadening and deepening understanding of the concept by the entire class. Some are suggested for use during art, math, or language time. Still others, the field trips, take the entire class out of the classroom and into the neighborhood for journeys of exploration and discovery.

Since the teacher will be starting with Unit One, a brief analysis of the first lesson (see pages T–14 and T–15) in that unit (rather than from some other unit) will serve to explain the headings of the main sections and help in developing an approach to teaching the lesson. The teacher may then proceed to use the suggestions with confidence and pleasure.

Closing the Lesson. A good science lesson rarely ends at the close of the science period. One of the criteria used by teachers in evaluating the effectiveness of their teaching is the enthusiasm with which children continue to observe and investigate on their own. The lesson, then, serves to point the way and to give meaning to children's continuing observations and investigations in their daily lives.

The first lesson in Unit One deals with *mechanical* energy used to set objects in motion. The four succeeding lessons deal successively with *electric* energy, *chemical* energy, and the energy in moving wind and moving water. These lessons are presented in the same teaching pattern as you will find for other lessons in other units.

Closing the Unit. The last section of each unit (see page 8), titled *Summary and Evaluation*, consists of a single lesson. The teacher will note that the central ideas of the lessons in the unit are brought together in a brief statement for her guidance. In the child's text, the corresponding page is titled "The Big Idea." This concluding lesson provides opportunity for review of vocabulary, summary of understandings, and evaluation of children's comprehension of the concepts of the entire unit.

These "Big Idea" lessons are designed for oral presentation in an atmosphere of self-appraisal. Children review their understanding. In our observation, they make statements which, even at a first level of understanding, come very close to the conceptual statement. They study and discuss pictorial problem situations, have games and word drills, browse through and reread the pages they have studied in the unit, and are encouraged to note and appreciate their growth in science. This growth is, of course, individual. But all the children come to some understanding of the concept. They can and do share an understanding of the world they have explored, each to his own capacity.

At the End of the Year's Work. Following the eleven units is an end-of-book section titled "Stories for a New View: Changes We See." These stories might be used as additional lessons for reinforcement. Page-by-page lesson plans are included, as they are for all pages in the text. Alternatively, the stories might be used as independent reading for the exceptional child who is able to read and work things out for himself. Or they might be read aloud by the teacher and discussed informally with the class. However they may be used, the stories were written to be enjoyed by the children as they apply the concepts they have learned to new situations and discover new relationships in the world about them.

For all the children, the text, carefully ordered in concepts, growing in complexity as the child grows in maturity, provides a series of firm foundation stones on which they may be guided to a firmer understanding of the higher ordering of concepts in *Concepts in Science 2*.

Each science lesson, then, permits the child

1. to explore the material universe (through a "mix" of activity)
2. to seek orderly explanations of the objects and events explored (the explanation is in an assertion we have called a *concept*)
3. to test his explanations (through a variety of activities).

The teacher's art is an individual one; the child's learning activity is an individual one. Nevertheless, the teacher's art is congruent to the scientist's when the child—in the teacher's hands—explores his world and, because of the teacher's great skill and understanding, is not crushed by the immensity of it.

Each lesson, in short, becomes an experience in search of meaning. A new concept of the way the world works becomes part of the child's equipment. He grows.

UNIT ONE: MAKING THINGS MOVE

The **title of the unit** indicates, in language for the child, the subject matter of the unit.

CONCEPTUAL SCHEME
When energy changes from one form to another, the total amount of energy remains unchanged.

At the top of the page that introduces each unit to the teacher, the **conceptual scheme of the unit** is stated in scientific terms.

Children live in a world of motion: toys move, balls are thrown, planes fly overhead, rockets blast off, cars and trains whiz by, electric washing machines and all the other household appliances hum and buzz as energy makes things move. Children bring to class a wealth of experience with energy in many forms. Through the activities in Unit One, they are helped to become aware of the relationships between energy and motion.

The **subject matter and activities of the unit** are selected for and related to the natural interests and activities of children.

The Conceptual Scheme. The total amount of matter and energy in the universe remains constant. For the purposes of the first grade, we have isolated the concept of energy for emphasis. As the child grows in experience, he will be given the opportunity to observe the relationship between matter and energy. New forms of energy may be discovered and used, as happened with the development of atomic energy; but the energy was there all the time. Man did not create it; he merely discovered and released it. Man, as scientist, does not really discover something "new": he discovers a relationship not previously understood.

The conceptual scheme is **interpreted for the teacher.** It is related to familiar occurrences (to the observations that children make and to the kinds of questions alert children ask).

Energy is used, but is never "used up." Energy in one form may be changed to energy in another form. For instance, the energy from the falling water at Niagara is changed to electric energy. We then use the electric energy as it is changed to heat energy (in a toaster) or light energy (in a lamp) or mechanical energy (in a power saw).

The major conceptual scheme involves far more, of course, than young children need be concerned with. It is useful to keep the major scheme in mind and use it as a framework for the lessons in this unit. Questions will certainly arise beyond the scope of the lessons in Unit One; then the conceptual scheme also serves as anchor.

The information on the introductory page, though brief and specific, goes considerably beyond the first-grade level. It is recognized that teachers have many claims on their time and energies. It is hoped that the **background information** that precedes each unit will render unnecessary any further research on the teacher's part before beginning to teach the unit with confidence and enthusiasm.

The major concept in Unit One is that energy is used whenever something is made to move. The concept is not, of course, taught directly but is discovered by the children gradually through their experiences in the lessons in the first unit. Other concepts about energy will be developed later. In the early grades the concepts and subconcepts concerning matter and energy are "seeded" in order to give the children a broad base for exploring the interaction of matter and energy in the universe.

Section 1: Sources of Energy

The **title of the section** states for the teacher the **topic** that is dealt with in the lessons in that section. It is a convenience for the teacher. Each section is, for the most part, primarily concerned with one major concept which is stated directly under the section heading. Each of the lessons develops a subconcept, stated directly under the lesson number.

CONCEPT
Energy must be used to set an object in motion or to alter its motion.

The **concept** is the same for all of the lessons in this first section. Often, the lesson also has a subconcept, which is a subdivision of the main concept.

THE PATTERN OF A LESSON

The **page numbers** in the child's text are given.

The **subconcept** is the specific concern of this specific lesson. Like the concept, it is stated for the teacher as a framework for planning experiences and directing questions.

This brief statement of the **aim of the lesson** gives the main understandings that children may be expected to reach through the activities of the lesson.

Each **lesson is introduced** by some activity that raises a question or poses a problem.

The teacher now proceeds to **develop the concept** by means of selected activities.

1. Using the pages of the child's text as the center of interest, the teacher guides children's attention from picture to picture, where **problem situations** (directed at concept-seeking) are shown. Procedures for the teacher to follow are suggested. Since each teacher is sensitive to the unique situation in her own classroom, it is likely that no two teachers will proceed in exactly the same way. With some groups, more activity may be desirable. With other groups, more discussion may be needed.

2. In bold-face type are **questions** which the teacher may wish to ask. Individual teachers may need to alter the wording of the questions to suit the verbal maturity of the class.

Beyond the specific science period, understanding of the **concept may be extended** by means of any of the activities described in this special section at the end of each lesson. The activities, which vary from lesson to lesson, are self-explanatory.

Note the words ***energy*** and ***food*** in heavy italics. Words printed thus are **key concept words**; these words children are helped to understand and encouraged to use. The children are not, however, expected to be able to read or write such words, though eventually a few children may be able to do so.

LESSON 1, pages 2 and 3

SUBCONCEPT: Mechanical energy may be used to set an object in motion.

Aim of the Lesson

Children are given the opportunity to discover relationships between motion and energy. They see that energy is needed in order to make something move.

Introducing the Lesson

REQUIRED: an alarm clock, not wound.

Encourage the children to look at the hands of the clock and to listen for its tick. They will discover that the hands are not moving and the clock is not ticking: the clock is not running. A child may suggest that perhaps the clock is broken. Ask how the class might find out whether or not this is so. When someone suggests that the clock may need winding, let him (or her) wind the clock. Once again let the children look and listen.

Why is the clock running now? Why wasn't it running before?

Developing the Concept

(by emphasis on the subconcept)

1. Call the children's attention to the picture of the toy dog at the top of page 2. Guide them into a discussion of why the dog apparently is not moving and what can be done to make it move. Let several children tell their own experiences with windup toys. During the discussion, refer the children to the other pictures on page 2: the hand turning the key to wind the spring and the toy moving as the spring unwinds. Here you may wish to allude once again to the clock.

. . . . . .

At the appropriate time, suggest that the children follow the words **What makes the toy dog move?** at the bottom of the page while you read the question aloud. We say that ***energy*** makes the dog move. Raise the question as to whether the key alone or the spring alone might be able to make the dog move. From the children's responses you will be able to lead the class to see that the key and the spring and the toy dog were all present in the first picture, but there was no movement: there was no energy being used.

. . . . . .

Extending the Concept

Through Activity. Collect *old* windup clocks and toys for the children to examine and take apart.

Through Key Concept Words. You may wish to begin a Vocabulary Chart with the words ***energy*** and ***food***. You may also wish to introduce the word *science*. If so, as this latter word is presented, encourage the children to browse through their science textbooks.

Visual Aids

Films and filmstrips are useful in clarifying and extending the understanding of concepts. Teachers may select with confidence from those listed below. Each one has been previewed carefully and is recommended for its appropriateness with certain lessons and units.[1] They have also been screened for the proper grade level.

It is important that films and filmstrips be ordered or reserved on loan well in advance of the time a teacher expects to use them.

FILMS

Each film is designated as being suitable for primary or intermediate grades. Those bearing the latter designation will require more careful planning for teacher presentation. Even though the films have been selected on the basis of appropriateness, it would be useful for the teacher to preview them in order to plan the lesson. The film may be shown at any time during the unit but its use should be planned and correlated with a single lesson.

All films are in color. Names of suppliers have been abbreviated; the full names and addresses follow this listing of both films and filmstrips.

Unit One or Unit Two

Making Things Move (11 minutes), #2013. EBF. A series of practical experiences with farm equipment show the forces that cause motion or retard motion. (Primary)

Unit Three

Magnets and How We Use Them (11 minutes), Film Association, 1964. First introduction to magnets. (Primary)

Unit Four

Thermometers and How They Work (11 minutes), #2067. EBF. Expansion and contraction; temperature, its importance and how it is measured. (Primary)

Unit Six

Shadows on Our Turning Earth (11 minutes). Film Association. Day and night result as the Earth moves continuously into and out of its shadow. (Primary)

Unit Seven

Learning About Seeds (11 minutes), #1529. EBF. Through time-lapse photography, we see seeds sprout and plants grow. (Primary)

Unit Eight

Farm Babies and Their Mothers (11 minutes). Film Association. Farm animals seen in natural environment. Especially good for classes unable to visit a real farm. (Primary)

[1] Films and filmstrips were previewed by Bess S. King, formerly supervisor of Santa Monica Public Schools, Santa Monica, California.

Farm Animals, Second Edition (11 minutes). EBF. Film emphasizes the care of farm animals; shows livestock products to be used as food. (Primary and Intermediate)

Zoo Animals (10 minutes). Film Association. A visit to a large zoo, where young children see animal families. (Primary)

Unit Nine

What Plants Need for Growth (11 minutes), #1690. EBF. Simple investigations show the basic needs of plants; shows reaction of plants in favorable and unfavorable environments. (Primary)

A Balanced Aquarium (11 minutes), #859. EBF. How to set up and care for a balanced aquarium. Shows relationship between green plants and animal life. (Primary and Intermediate)

Unit Eleven

The Dinosaur Age (15 minutes). Film Association. Shows past life on Earth as museum paleontologists discover fossil remains of a giant reptile and reconstruct its skeleton. (Intermediate)

FILMSTRIPS

Titles which have been starred (*) are recommended especially for developing the concept; others for extending the concept.

Units One and Two

None available to aid in concept development at this level.

Unit Three

**Discovering Magnets* (30 frames), #1 from a series of filmstrips called Magnets. Jam Handy. Shows how a magnet can be used to do work.

Different Kinds of Magnets (30 frames), #2 from a series called *Magnets*. Jam Handy. Magnets of various sizes and shapes; introduction of magnetic poles.

Magnets Help Us Find Direction (30 frames), #3 from the series called *Magnets*. Jam Handy. (Use for extending the concept with rapid learners.) Use of bar magnets; use of a magnet to make another magnet; simple ways of making a compass.

Unit Four

Heat Changes Things (34 frames), #4 of a series called *First Experiences with Heat*. Jam Handy, 1963. (Use in Lesson 2 to extend the concept with rapid learners.) Solids, liquids, and gases explained in terms of molecules. Excellent, simple presentation of heat designed for kindergarten through Grade 3.

**Where Do We Get Heat?* (33 frames), #1 of *First Experi-*

ences with Heat. Jam Handy, 1963. (Use in Lesson 5 or 6.) Simple presentation of heat from various sources, and what heat can do.

**Heat Makes Things Expand* (34 frames), #5 of *First Experiences with Heat.* Jam Handy, 1963. (Use in Lesson 6, 7, 9, or 9.) Excellent background for understanding the thermometer. (Follow up with next title.)

**Thermometers* (31 frames), #6 of *First Experiences with Heat.* Jam Handy, 1963. Colored drawings show children using thermometers to develop understanding of concepts. Captions give clear directions for investigations.

Unit Five

**How Does Water Get into the Air?*
What Makes Things Dry Faster?
Where Do Clouds Come From?

Three filmstrips (29 frames each), #2, #3, #4 of a series called *First Experiences about Weather.* Jam Handy. (Useful to introduce the unit.) Excellent introduction to concepts of cloud formation and precipitation.

Finding Out About Clouds (25 frames), #424–11. S.V.E. (Use in Lesson 3, 4, or 6.) Colored drawings and simple captions present the water cycle, simple investigations, and how to keep a weather chart.

Air Around Us (36 frames), #T435–7. SVE. (Useful to conclude the unit.) Clear but simple presentation of Earth's atmosphere; gives visual explanations of winds, kinds of clouds, rain and snow, etc. A good review of concepts, plus a new view.

Unit Six

**Day and Night* (27 frames), #424–12. SVE. Answers questions about light from Sun and Moon. Suggests simple investigations. Excellent illustrations; easy to read captions.

Night and Day (48 frames), #8321. EBF. Color drawings and simple worded text develops concepts of day and night.

Our Home, the Earth (35 frames), #425–2. SVE. Concepts of day, night, seasons, directions, and gravity are developed with colored child-like drawings. Unusually good for rapid learners if teacher reads the captions.

Unit Seven

Plants Around Us (12 short strips, 14 frames each) #9960. EBF. Kinds of plants and where they grow, their needs, parts of a flowering plant, and plants as food, etc. Excellent for first grade. May be projected, but are especially designed for individual viewing through hand viewer; good real-life color photography.

**Plants We Know* (31 frames), #435–5, SVE. Beginning of a plant in a seed; life cycle of a bean plant, needs of plants; experiments to do with seeds.

**Finding Out About Seeds, Bulbs, and Slips* (28 frames), #424–7. SVE. Excellent close-ups showing how seeds travel and how plants reproduce.

Plant Experiments (31 frames), #T436–1. SVE. Colorful drawings guide children and point out things to be observed when experimenting with plants.

Unit Eight

**Learning About Animals* (12 short strips, 14 frames each), #9940. EBF. (Use near the beginning of the unit.) May be projected, but are especially designed for hand viewer. Photographed from life in full color; many close-ups. Common farm animals and household pets. Excellent views of young with parents.

**How Animal Babies Grow* (26 frames), #424–2. SVE. (Use in Lessons 3 or 4.) Drawings and very simple captions develop concept of like begetting like. Includes the life cycle of the butterfly.

Animal Babies (13 frames), #T435–1. SVE. (Use in Lesson 5 or 6.) Care and training of young by the parents; effects of heredity.

*Pets (32 frames), #T435-15. SVE. (Use in Lesson 6, 7, 9, or 10.) Care and feeding of goldfish, toads, frogs, turtles, birds, rabbits, hamsters, raccoons, cats, and dogs. Excellent for average first graders.

**Large Zoo Animals*, #935–1, and Monkeys and Small Zoo *Animals*, #935–2 (39 frames each). EBF. (Use with Lesson 8.) Excellent photographs made in a large zoo, especially for a class that cannot visit a zoo.

**Birds of Our Community* (29 frames), #461–1, and *Homes of Birds* (37 frames), #461–4. SVE. (Use in Lesson 10, 11, 12, 13, or 14.) Real-life color photography; made especially for children in primary grades.

Unit Nine

**Plants Around Us*, a series of 6 filmstrips (25 frames each): (1) *Where Green Plants Grow;* (2) *What Do Green Plants Need for Growth;* (3) *How Green Plants Grow;* (4) *New Plants from Seeds;* (5) *New Plants from Older Plants;* (6) *Green Plants Are Important to Us.* Jam Handy, 1964. (Useful early in the unit.)

Farm Animals (32 frames), #T435–14. SVE. (Use with Lesson 7). Drawings show farmer caring for his stock: pigs, cows, horses, sheep, and chickens.

**How to Make an Aquarium* (30 frames), #4 of the series *The World Around Us.* Jam Handy. (Use in Lesson 8 or 9). Colored pictures with simple captions give directions for making an aquarium.

Unit Ten

Finding Out How You Grow (26 frames), #424–3, SVE. Basic growth patterns, body needs, and health facts are explained with interesting color drawings.

Unit Eleven

Dinosaurs (33 frames), #A435–13. SVE. (Parts of this filmstrip may be shown with the appropriate lessons, and the entire filmstrip used as part of the review activities.) Shows types of dinosaurs, how they developed from earlier forms of life, and how they lived. Also shows mammoth, sabertooth tiger, fossils, and what we learn from them.

Names and Addresses of Distributors

EBF	Encyclopaedia Brittanica Films, Inc., 1150 Wilmette Ave., Wilmette, Ill. 60091
Film Association	Film Associates of California, 10521 Santa Monica Blvd., Los Angeles, Calif. 90025
Jam Handy	Jam Handy Organization, 2821 E. Grand Blvd., Detroit, Mich. 48211
SVE	Society for Visual Education, Inc., 1345 Diversey Parkway, Chicago, Ill. 60614

Lesson Plans for the Teacher

CONTENTS

UNIT ONE: MAKING THINGS MOVE

CONCEPTUAL SCHEME
When energy changes from one form to another, the total amount of energy remains unchanged.

Children live in a world of motion: toys move, balls are thrown, planes fly overhead, rockets blast off, cars and trains whiz by, electric washing machines and all the other household appliances hum and buzz as energy makes things move. Children bring to class a wealth of experience with energy in many forms. Through the activities in Unit One, they are helped to become aware of the relationships between energy and motion.

The Conceptual Scheme. The total amount of matter and energy in the universe remains constant. For the purposes of the first grade, we have isolated the concept of energy for emphasis. As the child grows in experience, he will be given the opportunity to observe the relationship between matter and energy. New forms of energy may be discovered and used, as happened with the development of atomic energy; but the energy was there all the time. Man did not create it; he merely discovered and released it. Man, as scientist, does not really discover something "new": he discovers a relationship not previously understood.

Energy is used, but is never "used up." Energy in one form may be changed to energy in another form. For instance, the energy from the falling water at Niagara is changed to electric energy. We then use the electric energy as it is changed to heat energy (in a toaster) or light energy (in a lamp) or mechanical energy (in a power saw).

Green plants, growing in sunlight, use energy from the sun to make food from the substances in air and water and from minerals dissolved in soil. Animals cannot make their own food: they all depend on plants, directly or indirectly, for food. Food in the body yields energy. The energy results from chemical changes in food taking place in the body. Animals, including man, then use this energy when they move. We are dependent upon this energy, which we receive from our environment. There is, in short, a constant flow of energy between living things and their environment.

The major conceptual scheme involves far more, of course, than young children need be concerned with. It is useful to keep the major scheme in mind and use it as a framework for the lessons in this unit. Questions will certainly arise beyond the scope of the lessons in Unit One; then the conceptual scheme also serves as anchor.

The major concept in Unit One is that energy is used whenever something is made to move. The concept is not, of course, taught directly but is discovered by the children gradually through their experiences in the lessons in the first unit. Other concepts about energy will be developed later. In the early grades the concepts and subconcepts concerning matter and energy are "seeded" in order to give the children a broad base for exploring the interaction of matter and energy in the universe.

When something is made to move, energy is used. Nothing can be made to move without using energy from some source. A rocket remains on the launching pad until it receives energy from the fuel that sends it blasting off into space. An automobile runs only when fuel (gasoline) is burning in the engine. When electricity is shut off, our electrical appliances cannot move anything, for they have no source of energy.

A toy train does not move until something or someone makes it move. A child may push it or pull it and thus provide the energy to make it go. If it is a windup train, the child may supply the energy by winding the spring. The energy comes from the person who does the winding. The energy is then stored, or held, in the spring till the spring starts to unwind.

When a child throws a ball, he is using energy to make the ball move. The ball, or a balloon or other object, can also be made to move by energy from moving air (wind) or moving water. Energy from water is used to turn huge machines which generate electricity. Energy, as the child will learn, is defined as the capacity to do work.

UNIT ONE: MAKING THINGS MOVE

Section 1: Sources of Energy

CONCEPT
Energy must be used to set an object in motion or to alter its motion.

LESSON 1, pages 2 and 3

SUBCONCEPT: Mechanical energy may be used to set an object in motion.

Aim of the Lesson

Children are given the opportunity to discover relationships between motion and energy. They see that energy is needed in order to make something move.

Introducing the Lesson

REQUIRED: an alarm clock, not wound.

Encourage the children to look at the hands of the clock and to listen for its tick. They will discover that the hands are not moving and the clock is not ticking: the clock is not running. A child may suggest that perhaps the clock is broken. Ask how the class might find out whether or not this is so. When someone suggests that the clock may need winding, let him (or her) wind the clock. Once again let the children look and listen.

Why is the clock running now? Why wasn't it running before?

Developing the Concept
(by emphasis on the subconcept)

1. Call the children's attention to the picture of the toy dog at the top of page 2. Guide them into a discussion of why the dog apparently is not moving and what can be done to make it move. Let several children tell their own experiences with windup toys. During the discussion, refer the children to the other pictures on page 2: the hand turning the key to wind the spring and the toy moving as the spring unwinds. Here you may wish to allude once again to the clock.

At the appropriate time, suggest that the children follow the words **What makes the toy dog move?** at the bottom of the page while you read the question aloud. We say that ***energy*** makes the dog move. Raise the question as to whether the key alone or the spring alone might be able to make the dog move. From the children's responses you will be able to lead the class to see that the key and the spring and the toy dog were all present in the first picture, but there was no movement: there was no energy being used.

Have the children demonstrate with their fingers how they turn a key to wind a toy. Now get them to suggest a source for the energy needed to move their fingers or to wind a spring. If ***food*** is not mentioned, skillful questioning may elicit the proper response. Discuss energy from food being used when fingers are moved to wind the spring and the release of energy when the toy dog moves (energy from food, to moving fingers, to winding spring, to moving dog).

2. Now have the children look at the pictures of a live dog on page 3. Raise the question as to whether a real dog is ever actually still as the toy dog is. **Does a real dog use energy when it walks and runs? Does it also use energy just to breathe and stay alive? Where does this energy come from? Where and how do people and animals get their energy?**

By means of class discussion of the pictures, help the children to realize the following:

> Energy is used when the real dog moves and when the toy dog is wound.
>
> The energy used by the real dog and by anyone who winds the toy dog is supplied from food. The energy is released as the wound-up spring moves the toy dog.
>
> Without energy, no person could move, nor could anyone make anything else move.

3. To reinforce understanding, have a pupil come forward and demonstrate what made the clock go. Call for pupil responses to **What made it go?** In their own words, pupils can express the idea that energy supplied by the winding made the clock go.

What makes the toy dog move?

To determine the success of the lesson, let the children discuss what would happen in the following make-believe situation: Let's imagine that there is no food anywhere in the world. **Could a dog chase a ball? Could "Joan" wind our clock? Could a horse pull a wagon? Could anybody move or make anything move for very long after the food was gone?**

As the children give their answers, encourage them to explain in terms of what they know about energy.

Extending the Concept

Through Activity. Collect *old* windup clocks and toys for the children to examine and take apart.

Through Key Concept Words. You may wish to begin a Science Vocabulary Chart with the words *energy* and *food*. You may also wish to introduce the word *science*. If so, as this latter word is presented, encourage the children to browse through their science textbooks.

Through Art. Suggest that children make pictures of people or animals moving things. Use some of the pictures for a first section of a class picture book on ENERGY. Title the section ENERGY FROM FOOD.

With Slow Learners. Ask children to bring windup toys to school. Let them take turns demonstrating how they use energy to make the toys move.

With Rapid Learners. Assign children the problem of finding out what the spring is for and how it is used in a windup toy or clock. Give them this hint: the spring does something with the energy that is put into it by winding. (It obtains and stores energy when the key is turned. Then the spring releases the energy gradually as it unwinds. The energy thus released makes the clock or toy move.)

What makes the real dog move?

LESSON 2, page 4

SUBCONCEPT: Electric energy may be used to set an object in motion.

Aim of the Lesson

Children are given the opportunity to discover the relationship between electric energy and motion.

Introducing the Lesson

REQUIRED: an electric clock, not connected to an outlet.

Show the children the electric clock, and ask them whether or not this clock is run down. They will recognize that this is an electric clock and will suggest plugging in the cord to make it run. Plug in the cord, and let the children listen to the faint humming sound and see the movement of the hands on the clock.

How can this clock go without being wound? Where does the energy come from?

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: both a hand-wound and an electric record player.

1. The children will notice at once that the hand-wound record player, shown at the top of page 4, has to be wound up to turn the record. If a toy player is available, ask someone to explain why he turns the crank to wind it and what happens when the machine runs down (the spring is unwound). Explain that the first record players were all hand-wound and usually had to be rewound after each record. Demonstrate the winding-up and running-down process.

2. Discuss why the electric record player is an improvement over the hand-wound kind. If there is an electric player in the room, use it during the lesson. While a record is playing, disconnect the cord and ask why the record stopped moving (use a record that has been damaged).

Suggest that the children look at the question at the bottom of page 4 while you read it aloud. Have them show with their hands and arms how winding makes the hand-wound player go. How does ***electricity*** get to the second player to make it go?

Then put the following question: **Where does the *energy* come from?** Through discussion and study of the pictures, help the children to review what they learned about energy from food (Lesson 1). Lead them into a discussion through which they will develop the following assumptions:

Both record players use energy to move the records.

The energy used by the hand-wound record player comes from the person who does the winding; the energy is supplied from food. If there is no winding, there is no movement of the record.

The energy used by the electric record player comes from electricity.

If the plug is pulled out, there is no movement of the record.

3. Review with the children their experience with the two kinds of clocks. Help them to compare the clocks with the two kinds of record players.

Let children show their understanding by first looking at the pictures on page 4 and then reacting to the situations given here:

A girl is ill. She wants a record player that will play for a long time without stopping. **Which of the two kinds illustrated should she choose? Why?**

A family is having a picnic in the woods. They brought along a record player. **Which of the two kinds illustrated did they bring? Why?**

Extending the Concept

Through Investigation. Help children to take apart a well-insulated electric cord and examine the plug. Let them see how thoroughly all wires are covered. Use this experience as a basis for a lesson on safety and explain the dangers of worn or twisted cords and of playing with electricity.

Ask children to find out about the different kinds of motion that are caused by using energy from electricity.

If an old music box is available, remove the mechanism, and give the children a chance to discover how motion causes the tinkling sounds that play the tune.

Through Demonstration. By demonstrating small electric appliances, show how energy from electricity is used to do work; use an electric pencil sharpener, can opener, mixer, clippers, etc. (NOTE: Always caution children against touching electric cords, plugs, outlets, or moving parts.)

Through Key Concept Words. Add *electricity* to the Science Vocabulary Chart.

Through Art. Suggest making pictures of devices that use energy from electricity to cause motion. Place the pictures in a section of the class book on ENERGY. Title the section ENERGY FROM ELECTRICITY.

What makes it move?

LESSON 3, page 5

SUBCONCEPT: Chemical energy may be used to set an object in motion.

Aim of the Lesson

Children are given the opportunity to discover the relationship between chemical energy (a fuel as a source of energy) and motion.

Introducing the Lesson

REQUIRED: a tricycle.

Invite the children to demonstrate different ways of moving the tricycle. Each time they make it move, help them to be aware of the use of energy.

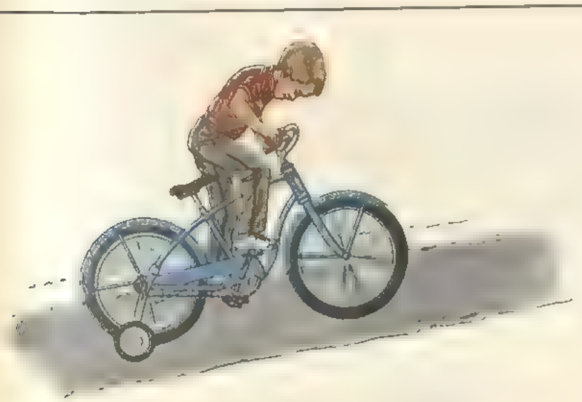
Review with the children the idea that they use food as a source of energy. Discuss briefly how this energy enables them to use their muscles.

Developing the Concept

(by emphasis on the subconcept)

1. After the children's experiences with the tricycle, have them look at the picture at the top of page 5. Have someone explain that the boy is using energy to push on the pedals to make the bicycle move. If any children have already tried to ride a "two-wheeler" get them to describe their experiences.

2. Direct the children's attention to the picture of the motorbike at the bottom of page 5. Ask whether they think it is easier or harder to ride the motorbike than a regular bicycle. Why? Read the caption on the pupil's page.



What makes it move?

5

Even though the children have had no experience with motorbikes, a study of the pictures will show them that the boy on the motorbike does not have to use his own energy to make the bike go.

To help children realize what makes the motorbike go, ask whether the boy in the lower picture can ride for quite a long time without stopping. Ask the children to recall some long trips they have taken in automobiles. **Was it necessary to stop occasionally for gasoline?** Encourage children to tell what happens to a car when it "runs out" of gasoline. (It is well to explain that when we speak of "gas" at a gas station, we are using a short word for ***gasoline.*** Otherwise, the children may be confused later when they learn about *gas* as one of the states of matter.)

Through discussion of the children's personal experiences and observations, help them to recognize that the engine of a car or motorbike can make the vehicle move only when it is using gasoline. The energy is supplied, not by the motor, but by using a ***fuel,*** in this case, *gasoline.*

3. Introduce the idea of gasoline and food as two sources of chemical energy by comparing the sources of the energy being used to move the bicycle and the motorbike shown on page 5. Through further discussion, help the children to reach the following assumptions:

Food supplies energy to make the bicycle move.

Gasoline supplies energy to make the motorbike move.

Food and gasoline are both sources of energy.

Extending the Concept

Through Field Trips. Accompany the children on a walk around the school to observe vehicles that use energy from gasoline.

If the school has a lawn that is mowed by a power mower, arrange for the operator to demonstrate it to the class, show them where the gasoline is put in, and point out the advantages of a power mower over a hand mower, and vice versa.

Through Key Concept Words. Add *fuel* and *gasoline* to the Science Vocabulary Chart.

Through Arithmetic. Show a gallon can, and explain that we buy gasoline by the gallon. Using the can, some water, and a quart milk carton, let children discover that there are four quarts in one gallon.

Through Art. Suggest making pictures of things that use energy from gasoline. Use the pictures as a section in the class picture book on energy. Title the section ENERGY FROM GASOLINE.

Through Class Discussion. Present the following problem to be investigated at home: What happens to the gasoline in the tank of a moving vehicle?

When the reports come back that the gasoline is *burned* in the motor to supply energy, explain that food is changed chemically in the body to supply energy. The gasoline burns rapidly with considerable heat, whereas food in the body changes more slowly with less heat.

LESSON 4, page 6

SUBCONCEPT The energy in moving air may be used to set an object in motion

Aim of the Lesson

Children discover that moving air (wind) has energy

Introducing the Lesson

EQUIPMENT a large ball, a large, round balloon, inflated by breathing into it, a piece of stiff cardboard to use as a fan

Have the children toss the ball and the balloon from one child to another. Encourage them to explain how they use their muscles to make the ball and balloon move. Through discussion have them recall their dependence on food as a source of energy

Place both the ball and the balloon on a table (with no air currents), and choose someone to explain why the objects are no longer moving. Then challenge the class with the following: **How can you make the balloon move without touching it?** The children will discover that they can move the balloon by blowing on it. Wave the cardboard fan and then offer it to one of the children to use

Developing the Concept

(by emphasis on the subconcept)

1. Have the children look at the bottom picture on page 6. Suggest that they use their own experience in throwing a ball to explain the source of the energy that moves the ball shown in the picture

2. Ask whether it appears that the girl in the picture is throwing the balloon. The situations illustrated are different. Choose a child to tell the story about the picture, calling attention to the indications that a strong **wind** is blowing. Let the children share personal observations of things that blow about on a windy day

Ask what would happen to the girl's balloon if the wind stopped blowing. Help the children to reason that with no wind the balloon would stop moving and would be motionless on the ground just as the balloon in the classroom is now lying on the table

3. [illegible] attention to the question on the page. By now, some children will be able to read it or they will remember the words from previous lessons. Elicit the idea that the boy is making the ball move and the wind is making the balloon move. Then raise the question **Where does the energy come from?** The children's responses will indicate whether they know that the balloon is being moved by energy from wind

[illegible] understand the [illegible] **How do you know that wind has energy?** The children may refer [illegible] to show that [illegible] and therefore wind has energy

[illegible] may be able to generalize using such [illegible] as the following:

Wind can make things move
It takes energy to make things move
Wind must have energy

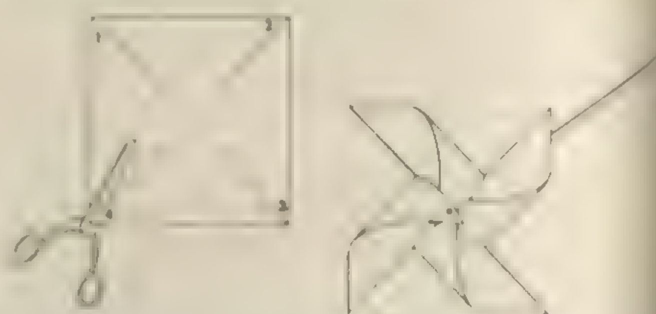
Extending the Concept

Through Activity. Help the children to make pinwheels of colored paper (see diagram below). Let them use their pinwheels and discover how energy from wind can make them turn

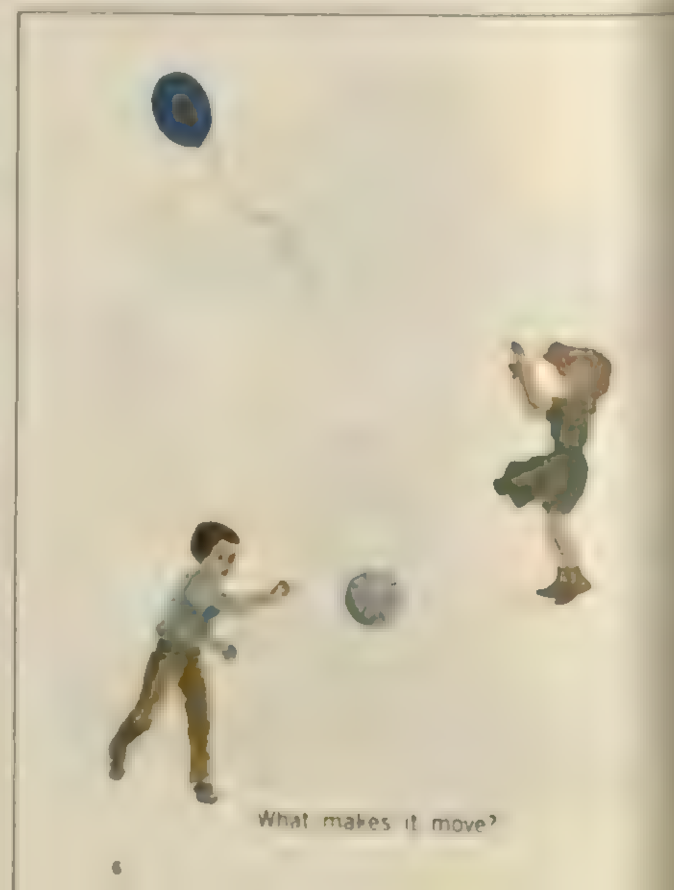
Through Investigation. Encourage children to investigate moving air by using thin streamers of tissue, flags, and balloons on strings. They will discover that moving air, even when it apparently is not blowing as a wind, can supply energy to cause motion

Through Key Concept Words. Add *wind* to the Science Vocabulary Chart

Through New Situations. Show a picture or model of one or more of the following: a modern sailboat, a sailing vessel of the past, a farm windmill that pumps water, or a Dutch windmill that grinds flour. The children should be able to reason how wind is being used to do work.



Cut along diagonal lines nearly to the center. Put pin through 1, 2, 3, and 4 successively, and then through the center of square. Place on end of stick.



LESSON 5, page 7

SUBCONCEPT: The energy in moving water may be used to set an object in motion.

Aim of the Lesson

Children seek the relationship between the energy of moving water and the motion of objects.

Introducing the Lesson

REQUIRED: a pan of water, floating toy or toy boat without a sail

Have the water in the pan as motionless as possible. Let one child place the toy gently on the water. Have the children tell what the toy is doing; it is floating but not moving. Ask them to think of two ways by which they could make the toy move without touching it.

If necessary, remind the children of their experiences with wind. Then someone may suggest blowing on the toy or using a fan. Someone else may propose tipping the pan or stirring to move the toy. Let them try out their suggestions.

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: an outdoor hose connected to a source of water, an aquarium with at least one fish

1. Ask the children to look at the picture at the top of page 7. Encourage them to tell about watching leaves, twigs, and toy boats floating down a stream or down a gutter after a heavy rain. If your area has experienced flood conditions recently, extend the discussion to include such things as floating houses and furniture, and rocks, trees, and soil being moved by **water**.

If possible, take the class outdoors for a short period, and use a stream of water from a hose to move small rocks, toys, sand, or other objects. If this experiment is not possible, discuss the use of a hose to clear away dead leaves and to clean off sidewalks.

It is important to call attention to the fact that the *moving* water in the gutter (picture on page 7) and from the hose was making other things move. Let the children observe again that the toy floating in the pan does not move until something makes it move.

In discussion, help the children reach the following conclusions:

Water can be used to move things.

The energy that causes the motion of these things comes from *moving* water.

2. Ask the children to study the second picture on page 7, and consider the questions:

Does the water seem to be moving?

Does the fish seem to be moving?

Can a fish move only when the water is moving and only in the way the water is going?

If there is an aquarium in the room, have the children watch the fish to see that the fish are moving through the practically still water, and that they move in many directions.

Through a discussion of fish and how they use muscles to move their fins, lead the children to an understanding that fish do not depend on moving water to move them. By now most children will recognize the question on the page. Appropriate questioning may help children to appreciate that fish get their energy from their daily feedings. Ask what would happen to the fish if they were not fed.

3. You may determine children's understanding of sources of energy by the endings suggested for the following story:

"A boy built a raft. He loaded it with a blanket, some tools, some long poles, and some ropes. When he climbed onto the raft in the still water, the raft did not move. Suddenly the boy had an idea! He knew a way to make the raft move." **What did he do?**

Children may suggest that he used the blanket for a sail, he used a pole to push the raft, he swam and pushed the raft. Try to get them to describe the use of energy to make the raft move.

Extending the Concept

Through Activity. Help the children to make pinwheels of heavy aluminum foil following the diagram on page 6. Let them hold their foil pinwheels in a very gentle stream or spray from a faucet and see how the moving water makes them turn.

Through Key Concept Words. Add *water* to the Science Vocabulary Chart.

With Slow Learners. Supply the children with small match boxes, large corks, half shells of walnuts, and pieces of wood to use as boats. Let them try out their boats in basins or pans of water, showing how the boats can be made to move when the water is moved.

What makes it move?

7

UNIT ONE: MAKING THINGS MOVE

Section 2: Summary and Evaluation

CONCEPT SUMMARY
Energy must be used to set an object in motion or to alter its motion.
Different forms of energy (electric, chemical, mechanical, etc.) may be used to set an object in motion or to alter its motion.

LESSON 6, page 8

Aim of the Lesson

Children are given the opportunity to review the relationship between energy and motion. Through fresh experiences they fix the concept and the subconcepts.

A New View of the Concept

REQUIRED: a collection of toys, tools, appliances, and other objects that can be made to move: at least one live animal, such as a fish or a turtle (or a picture of one). Have as many of the items shown on page 8 of the textbook as are practical to collect and display. Arrange the things on and around a science table.

Have the children go to the table in groups of 6 or 8. Encourage them to look at, handle, and manipulate the various items and to discuss quietly with each other the ways in which each thing can be made to move and what causes the motion. (Have children look at and discuss the live animal without handling it.)

Fixing the Concept

1. Call the children's attention to the series of problem-situation pictures in addition to the objects on the science table. Let each picture and each object serve as a stimulus for individual responses about sources of energy. (THE BIG IDEA page concludes each unit and is designed to help the children evaluate their understanding of the concept.)

Encourage the children to *show* by physical activity how something can be made to move. After each child has made his demonstration, ask him to explain where the energy that caused the motion came from.

Help the children to fix the idea that there are several ways of moving most of the things. Choose individuals to push, pull, lift, blow on, or carry some of the small objects, using energy from their bodies.

2. Display some of the pictures made by the class, and have the children compose stories about energy to accompany the pictures. Add the child-made stories (written in manuscript by you) to the class picture book on ENERGY. You may wish to place the book on the library table.

3. Choose children who are able to write numerals in sequence to number the pages of the separate sections of the class picture-story book on ENERGY.

4. Review the words on the Science Vocabulary Chart:

science	electricity	gasoline	wind
energy	food	fuel	water

Have the children use each word in a sentence that will indicate a general understanding of the word.

5. The main point of this evaluation experience is to foster thoughtful application of the concept that energy from various sources may be used to set objects in motion. Answers or statements that stem from good thinking are to be encouraged.

You will know that this unit has fulfilled its purpose if the children, in their activities and explanations, apply the following ideas:

It takes energy to make anything move.

Things can be moved by using energy from different sources: food, electricity, a wound-up spring, gasoline (a fuel), wind (moving air), and moving water.

At the close of the lesson, the children should understand that they have learned about and used some of the important forms of energy. There are other forms of energy, which they will enjoy exploring later in their science work.

UNIT TWO: MOVING FASTER

Children experience the advantages of wheels long before they come to school. They play with wheel toys on the floor, pull wagons, ride tricycles, travel in buses and cars, and see wheels being used on household and farm equipment. Many children have toys that are working models of trucks, trains, and other vehicles and will enjoy bringing these toys to school.

Young children are aware of speed and are impressed by it. They know that rockets go faster than airplanes and that a car is speedier than a bicycle. They are interested in finding out why some things can move so fast. They are also interested in the gigantic machines that do enormous amounts of work. Many children have seen bulldozers cutting down hills and gouging out roadways. Some have watched combines, threshing machines, and other mechanized farm equipment. Nearly all children have had some experience with major household appliances. They can understand the use of more energy to do more work faster. They know, for instance, that more floor space can be cleaned faster with an electric vacuum cleaner than with a broom.

In Unit Two, children should have ample opportunity to draw upon their out-of-school experiences and to bring in and share any model machines they may have.

The Conceptual Scheme in this unit is the same as for Unit One (see page 1).

Energy And Work. When electric energy makes a toy train move, work is being done. When a scientist speaks of *work*, he has in mind a rather technical definition, much stricter than the general meaning of *work*. But we don't need that strict definition just yet. We'll use the word *work* in its general meaning. You will see that this will prepare the way for the scientific definition when we have need of it.

Man uses the sources of energy available to him to do more work and to do it faster. One horse may be able to move a load of hay. Two horses are able to move a greater load somewhat faster, and four horses can move a still greater load and considerably faster.

Increasing the amount of available energy through the use of larger and more efficient motors and better fuels has speeded up all forms of transportation. The use of more energy also gets more work done. Using energy from electric or gasoline motors, for instance, enables modern man to do far more work than he can do by using only the energy of his own body. A man with a shovel can dig a few small holes in a day. A power shovel, however, can make a huge excavation in a day. The equipment in a modern home illustrates as well as anything the concept of more energy (in this case from electricity) being used to accomplish more work. With modern equipment a housewife can do in a matter of hours the amount of work that her great-grandmother, using only her own body energy, spent many days doing. The large amount of energy now at our disposal makes a great difference in nearly every aspect of our lives.

Friction And Wheels. When two surfaces slide against each other, friction results. Friction is a resistance to motion. The more the friction, the greater is the amount of energy required to move something. When friction is being overcome, work is being done.

When an object is moved over a surface on rollers, wheels, or balls, rolling friction occurs. Rolling friction is less than sliding friction. With rollers or wheels friction takes place only at relatively small areas of contact: where the rollers touch the ground, floor, or table and where they touch the object that is being rolled. It takes much less energy to move an object on rollers than to slide it.

Early in man's history, the wheel was unknown. The discovery, or invention, of the wheel and axle marks one of the great advances in man's technological development.

UNIT TWO: MOVING FASTER

Section 1: Reducing Friction

CONCEPT
Energy is used to do work.

LESSON 1, pages 10 and 11

SUBCONCEPT: Energy is used to overcome friction (resistance to motion).

Aim of the Lesson

Children are given the opportunity to compare rolling friction and sliding friction. They observe that energy is required to overcome each and become aware of further relationships between energy and motion.

Introducing the Lesson

REQUIRED: a pair of roller skates, borrowed from a child in the class.

Have the child who owns the skates put them on and show the class (outdoors if possible) how he skates. Point out how far the skater can move with one small push and how easily he moves on skates. After watching the demonstration, most children will be eager to discuss personal experiences with skates. Lead the discussion toward this question:

Why can we move so easily on skates?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: one roller skate; several large rubber bands of uniform size.

1. As the children study the pictures on page 10, they may wonder what the boy is doing with the skate. Explain that the boy is doing an investigation. Call attention to the word, **Investigation,** at the top of the page and develop the meaning. We *do things*, we *try things out*, we *find out how things work*, we *read about things* when we do an investigation. We do investigations when we want to find out about something. We investigate when we want *to see for ourselves*. Let the children know that they will do many investigations in their science work.

Have children name the objects shown on the colored strip across the top of the page. Explain that these are the things the boy is using in his investigation. Then suggest that the class follow the words as you read the question on the page. Through discussion, help the children to understand that the boy is finding out which is the easier way to move a skate, on its side or on its ***wheels***, and that he is finding out by doing an investigation.

In answer to the question on the page, the children will quickly agree, from their own experience with skates, that the second way is easier. It is obvious to them that it is easier to roll a skate on its wheels than to drag it on its side. Without indicating agreement or disagreement with their answers, challenge them by asking how they can be *sure* which way is easier. Someone may then suggest that they do an investigation like the one that the boy in the picture is doing.

Agree that doing an investigation is a good way to find out. Ask whether it is necessary to repeat an investigation already shown (as in the picture). Suggest that to do so is a way of checking to be sure (the notion of confirmation through repetition).

2. Use one skate with a rubber band attached as in the picture. Choose a child to do the investigation, hooking one finger through the rubber band and pulling the skate, first on its side and then on its wheels, across a table. Have the child tell the group which way is easier and why he thinks so. Choose several children to repeat the investigation and report on which way is easier.

After the skate has been dragged and then rolled across the table a number of times, call attention to the way in which the rubber band stretches out when the pulling is hard, and stretches only slightly when the pulling is easy. Choose children to come forward and pull on rubber bands (one child at a time), discovering and reporting the effects of a hard pull and an easy one on the amount of stretching of a rubber band. Recall the earlier lessons on energy to help develop the idea that more energy is used with a hard pull than with an easy pull on the rubber bands.

Direct the children's attention back to the rubber band on the skate; help them to see that when the band is stretched

Which way is easier?

out to drag the skate, a hard pull is indicated. When the band is only slightly extended to roll the skate, an easy pull is indicated and less energy is used. Children will then offer the lengths of the rubber bands, as well as their own feeling about a pull, as evidence that it is harder to drag a skate than to roll it on wheels.

Now return to the earlier question about skating: **Why can we move so easily on skates?** Through discussion, lead children to the realization that it is easy to move on skates because it takes little energy to move on wheels.

3. Invite the children next to look at the picture of the children pushing the heavy toy box on page 11. Choose children to take turns moving some heavy objects in the room by pushing. Encourage each child to apply what he has learned about wheels by suggesting ways in which wheels can be used to move heavy objects more easily. In summarizing the discussion, help the children to express in their own words the following assumptions, based on experiences in Unit One as well as on the present lesson:

It takes energy to make things move; we take our energy from the food we eat.

It is easier to move ourselves on wheels than without wheels.

It also takes less energy to move other things on wheels than without wheels.

The relative success of the lesson will be indicated by the children's responses to the following practical problems:

Suppose that we have a big, heavy piano in the classroom. We want to move it from one side of the room to the other. We call our custodian, and he has a way to move it. **What does he do?**

Betty has a big television set in her house. It is very heavy, but her mother pushes it easily from one room to the other. **How can it be moved so easily?**

As children give their answers, encourage them to explain in terms of the relative amount of energy needed to move things with and without wheels.

Extending the Concept

Through Activity. Secure an old, but well-oiled ball-bearing roller skate and help children to take it apart. Let them discover the ball bearings and speculate as to their function.

Through Key Concept Words. Add *investigation* and *wheels* to the Science Vocabulary Chart.

With Slow Learners. Give the children blocks and pencils (or other rollers) and let them do further investigating with rolling and dragging across various surfaces: a smooth floor, up a slope, down a slope, across pavement, etc. Help them to experience the greater ease of rolling over dragging.

With Rapid Learners. Present two roller skates, one a ball-bearing skate and the other a beginner's skate, which has no ball bearings. Encourage the children to discover for themselves why the first kind goes so much more easily than the second kind (the bearings further reduce friction).

Which way is easier?

11

LESSON 2, page 12

SUBCONCEPT: More energy is needed to overcome sliding friction than to overcome rolling friction.

Aim of the Lesson

Children inquire into and investigate some of the causes and effects of friction.

Introducing the Lesson

REQUIRED: a sled or wooden box with rope attached, a wagon large enough to hold a child.

On the sidewalk or on the hard-top play area, have children take turns pulling each other, using first the sled or box with two children pulling and then the wagon with only one child pulling. Encourage them to observe how much harder it is (how much more energy it takes) to start something moving and to pull it around without the aid of wheels. Through discussion, lead them to questions such as these:

What is it that holds the box or sled back? Why is it easier to move something on wheels?

Developing the Concept

(by emphasis on the subconcept)

1. Give children time to study and compare the pictures on page 12. Explain that, in sections of the country, fields have been cleared of stones by the use of a stone board. It is more convenient and easier to lift the stones or roll them onto a low board than to lift them onto a wagon. In certain parts of the country stone boards are still used.

The children may be interested in knowing also that a similar conveyance (sometimes called a *travois)* was used generations ago as a means of travel by Indian families.

Point out the similarity between the way in which the stones are dragged and the children's experiences in pulling each other on a sled (or in a box). They will realize that the horses must use a considerable amount of energy to move stones in this way. Call attention to the roughness of the ground, and encourage children to interpret the scene as a means of pulling against friction; they may or may not use the word "friction."

If children do not use the word, introduce the word ***friction***, and explain the meaning in terms of what tends to hold things back and also wears things out when they are dragged.

Ask the children what friction had to do with their investigation with the roller skate (Unit Two, Lesson 1).

2. Direct children's attention to the pictures on page 12, and ask them which trip is easier and why it is easier. They already know that moving is easier on wheels and now should explain the reason in terms of friction:

When something is dragged, there is considerable friction, which holds the object back.

When something moves on wheels, there is much less friction than when it is dragged.

It takes less energy to move something when there is less friction.

Friction causes wear on surfaces that rub together.

To evaluate the effectiveness of the lesson and to relate it to the preceding one, present the following situations:

If you have a roller skate on one foot, and only a shoe on the other, which foot moves easier? Why?

Why do the soles of your shoes wear out after you have worn them for a long time?

Encourage the children to explain their answers in terms of friction retarding motion and causing wear.

Extending the Concept

Through Investigation. Use a large sheet of coarse sandpaper, a kindergarten building block with a rubber band attached for pulling, and two cylindrical pencils. Let the children feel the roughness of the sandpaper and the drag of friction when the block is pulled across it. Then place the pencils under the block to serve as rollers and have children feel that there is less holding back by friction when something is rolled than when it is dragged.

Through Key Concept Words. Add *friction* to the Science Vocabulary Chart.

Through Activity. Have children slide blocks over pieces of unfinished board. Then let them discover ways of reducing the amount of friction by applying liquid soap, oil (salad oil will do), or talcum powder to the boards. Next, let them increase the amount of friction by applying sand or salt to the boards.

Through Problem Situations. Ask children why we put oil on roller skates, wagon wheels, and bicycles. Ask what the oil does. (Oil, or other lubricant, reduces friction.)

Make two dowel sticks available to the class. Ask the class to invent a method by which they could pull a box along the floor by using the dowel sticks to reduce friction.

Which way is easier?

UNIT TWO: MOVING FASTER

Section 2: Comparing Amounts of Energy Used

CONCEPT
Energy must be used to do work.

LESSON 3, Page 13

SUBCONCEPT: The greater the amount of work done, the greater the amount of energy expended.

Aim of the Lesson

Children engage in activities which provide an opportunity to develop an awareness that going faster means that more work is being done. The more work done, the more energy expended.

Introducing the Lesson

Choose several pairs of children; both children in each pair should be about the same size. Have one child in each pair bend over and touch his or her toes rapidly while the other one does the same thing slowly. Appoint other pairs of children to check the count. Start them all at one time and stop them after about 10 seconds. Ask the children to explain whether one child in each pair bent over quite a few times more than the other. **Was the time the same for all? Do they think one child was moving faster than the other? Do they think one used more energy than the other? Does it take more energy for a child to move fast than to move slowly? Can anyone explain why children of about the same size were paired?**

Which way is faster?

13

Developing the Concept

(by emphasis on the subconcept)

1. Call the attention of the children to the pair of pictures at the top of page 13. Explain the difference in terms of energy between the boy walking in the first picture and the boy running in the second. Make a comparison between what is happening in the pictures and what happened in the bending exercise in the class. **What "educated guesses" or hypotheses can the children make concerning the amounts of energy used by the boy in these two pictures?** Try to get statements about the relationship between speed and energy. **Where does the boy get his energy?**

2. Now refer the children to the second pair of pictures. Encourage the children to tell what is going on in these two pictures. **Why is the car going slowly in the illustration on the right? In which picture is the car going fast? How do these two pictures compare with the first pair? Does the car use more energy than the boy in each case? Where does the car get its energy?**

3. **In the last pair of pictures, which indicates the greater use of energy?** Try to get a discussion similar to that for the other pictures. **Is the source of energy different here than in either of the other cases illustrated?**

At this stage you may expect the children to recognize these relations:

Going faster means more work is done per unit time.

The more work done, the more energy needed.

4. You may wish to review again the sources of energy used in this lesson—food, fuel, and wind.

Check for comprehension of the idea of available energy by asking the children to imagine that the boy, the car, and the sailboat all started at the same time. Which would be most likely to travel ten miles in the least time? **Under what conditions could a man travel ten miles on land faster than a sailboat on water?**

Extending the Concept

Through Investigation. Obtain a cardboard carton large enough to hold a child. Choose one of the smaller children to ride in the carton and a larger one to push the carton across the floor. Repeat the process with two and then three children pushing the carton. The extra pushers should make the carton go faster. Explain this in terms of using more energy to make things go faster.

Through Art. Suggest that children make pictures of things that use much energy to go fast but not so much energy when going slowly. Have them bring pictures of similar things from magazines.

LESSON 4, page 14

SUBCONCEPT: The rate at which energy is used determines how fast the work can be done. (This is developed in the upper grades as the concept of power — the rate of doing work.)

Aim of the Lesson

Children extend their awareness that more energy per unit of time is needed to increase the speed of motion.

Introducing the Lesson

REQUIRED: stamped envelopes that have traveled via air mail; some that have traveled via surface mail; a map of the United States.

Pass around the stamped envelopes. Have the children point out the differences they discover between air mail and regular stamps. Locate your community on the map, and tell how long it takes for a letter to reach you from New York (or Los Angeles) by air mail and by regular mail. Through discussion, stimulate curiosity about ways in which mail may travel.

Developing the Concept

(by emphasis on the subconcept)

1. Ask the children to interpret the meaning of the picture of the runner on page 14 as one way by which people sent messages long ago. In the illustration, the runner is carrying a message for the king. He would pass the message to a second runner, who, in turn, would pass it to a third runner, etc. Through discussion, establish the fact that the energy used to carry the message in this case is energy derived from food.

2. Next, refer to the second picture on page 14, and tell the story of the Pony Express, which, about a hundred years ago, carried mail between St. Joseph, Missouri, and Sacramento, California. Each man rode, in succession, three different horses, riding each as fast as possible. He then gave the mail to another rider. Locate St. Joseph and Sacramento on the map, and tell the children that it took a little more than a week to travel the route, using the energy of many horses. The horses also obtain their energy from food. Find out whether the children think that a horse has more energy than a man. Through appropriate questioning, lead children to these understandings:

Energy is used whenever something is made to move.

More energy is used per unit of time when something moves faster.

When planes go very fast, they use much energy.

A plane supplies more energy than a horse does, and a horse supplies more than a man.

Encourage application of the assumptions above by leading the class into a discussion of the following situation:

Years ago, families traveled across our country on foot, on horseback, and in covered wagons. **Why did it take so much longer to cross the country then than it takes today?** Encourage children to explain their answers in terms of sources and amounts of energy available.

Extending the Concept

Through Arithmetic. Collect and display stamped airmail postcards and stamped regular postcards, and compare the prices. Do the same for regular and airmail stamps for letters.

Through Activity. Have the class dictate a message to someone living in a distant city that is served by jet planes. Write two copies, one on an airmail postcard and one on a regular stamped postcard. Request the recipient to let the class know when each card arrives at its destination. Mail both cards at the same time.

Encourage children to collect various kinds of used stamped envelopes and classify them according to how they traveled. This will lead some children to a large map or globe to find places and trace probable routes.

Assign children the problem of finding out where locomotives get the energy they use. Provide books about trains for the children to consult. Encourage discussion of early wood-burners; coal-burning steam engines; diesel and electric locomotives.

Which way is faster?

UNIT TWO: MOVING FASTER

Section 3: Comparing Work Done

CONCEPT
Energy must be used to do work.

LESSON 5, page 15

SUBCONCEPT: The greater the amount of work done, the greater the amount of energy expended.

Aim of the Lesson

To provide experiences by which children can compare amounts of energy used and amounts of work done.

Introducing the Lesson

REQUIRED: A few ants on a white saucer (set in a pie tin filled with water almost to the saucer's rim); a small amount of granulated sugar and some bits of fried bacon; one or more magnifying glasses.

Give the children grains of sugar and bits of crumbled bacon to feed to the ants. Let them watch the ants through magnifying glasses. Point out the size of an ant in relation to the load it carries, and discuss food as the source of the ant's energy. (If ants are not available, use pictures of ants carrying loads.)

Which does more work?

Developing the Concept

1. On page 15 the children see the picture of an animal which they will enjoy comparing with the tiny ants. Through a discussion of ants and elephants, help the class to agree that the elephant is much bigger and can use its energy to lift a much heavier load. Ants, however, use a great deal of energy for their size. Of course, it is much less than that used by elephants. Encourage children to tell about any elephants they have seen, and keep referring to things that elephants lift (as in the picture), carry, push, and pull.

Review food as a source of energy, and refer to the food of ants (small particles of food) and of elephants (grasses, shrubs, etc.).

2. Now have the children look at the second picture on the page. Ask the children the question on the page. When they answer that the machine is doing more ***work*** than the elephant, try to get them to explain why. They should now be able to reason that the machine is doing more work because it is using more energy to lift a heavier load. Find out if anyone knows what the machine is called. Review fuel (in this case diesel oil) as a source of energy. Discuss with the children the ideas that:

All animals get their energy from foods.

The machine in the picture gets its energy from a fuel.

The machine has more available energy than even a big elephant, and so the machine can do more work.

To reinforce the lesson, ask the children how much work the machine could do if it ran out of fuel and what the elephant must have if it is to keep on doing work.

3. You will know how well the children comprehend the concept of more energy being used to do more work by their responses to the following problem:

Suppose that two men are going to build houses. Each one begins by digging a big hole in the ground for the foundation. One man digs the hole with a shovel. The other uses a big machine called a power shovel. **Which man digs the bigger hole in a day? Which way is faster? Which man is getting more work done?**

Encourage the children to explain their answers in terms of amounts of energy used.

Extending the Concept

Through Activity. Collect toys, models, and pictures of tractors, bulldozers, concrete mixers, power shovels, road scrapers, etc. Let children demonstrate how the machines operate, and tell about the work they do.

Through Key Concept Words. Add *work* to the Science Vocabulary Chart.

Through Investigation. Choose one child to do a job; for instance, to carry one or more books across the room. Then have the job repeated, using two, and then three children, each carrying the same number of books. Let the children discuss why two or three children use more energy and can do more work than one.

LESSON 6, page 16

SUBCONCEPT: More work can be done in less time when machines are used. Machines do not reduce the total amount of work.

Aim of the Lesson

To extend the realization that more work can be done when more energy is used.

Introducing the Lesson

REQUIRED: several newspapers, folded as for delivery.

Let children pretend that they have newspaper routes. Have a child pick up some papers and tell the class one way of making deliveries. Try to get different children to describe different ways, as walking, riding a tricycle or a bicycle, and being driven in a car. In each case, encourage the children to mention the source of energy, the length of the route, the quantity of papers, and the amount of time required to make the delivery.

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a bicycle placed upside down on the floor with exposed gears and chain.

1. Direct attention to the first two paper boys on page 16. Ask which boy can carry more papers, the one on foot or the one with the special bicycle. Seeing the extra bundle of papers, the children will assume correctly that the bicycle helps the second boy to do more work. Through discussion, bring out the fact that both boys are using only the energy of their own bodies. To create interest, raise the question as to how we can travel faster on a bicycle than on foot. You may get some peculiar responses, but move quickly to the inverted bicycle.

2. Have several children experiment in turning the pedals of the bicycle by hand. Ask the class to watch carefully in order to see what happens to the rear wheel as the pedals go around. Direct their attention to the gears and the chain. Help them to discover that when the pedal wheel makes one complete turn, the rear wheel of the bicycle goes around several times. If the bicycle were right side up, the rear wheel would go around on the ground several times for each turn of the pedal wheel. Because of the ***gears,*** the boy in the picture can travel faster on a bicycle than he can on foot. Also, since he can carry more papers, he can do more useful work.

3. Now direct the children's attention to the bottom picture on page 16 of the textbook. The pupils will quickly respond to the question **"Which does more work?"** by choosing the truck and will be able to explain their choice in terms of trucks having more energy than boys have. Ask: By which way can the most papers be delivered and by which way is it possible to travel the fastest?

By now, the children should be reaching some of the following important conceptualizations:

More work can be done when more energy is used.

Fuel, used in a machine, supplies energy at a faster rate.

Machines using fuels do more work in less time than man can do using only his own energy.

To give further emphasis to the importance of energy from fuels, initiate a discussion of trucks and the various things they bring to us (milk, other foods, coal and oil, furniture, building materials, etc.). Point out that we are also dependent on trucks for carting things away (garbage, rubbish), and for giving us protection (fire trucks, ambulances). Close the lesson by presenting the following question:

Could all of this work be done if we had only bicycles or tricycles—if we had no trucks or cars?

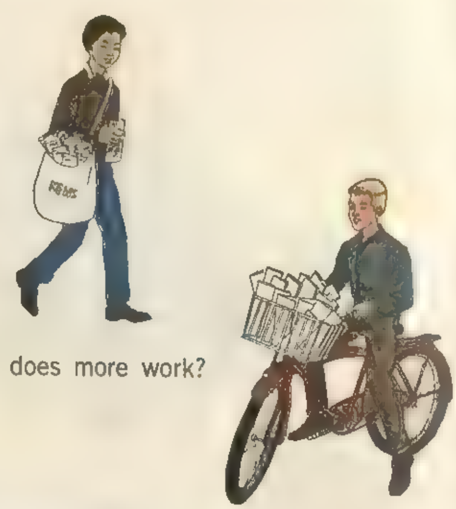
As children respond, they will show their understanding by comparing energy derived from food (used to pedal a bicycle) and energy derived from gasoline (used in a truck) and will explain the need for using large amounts of energy.

Extending the Concept

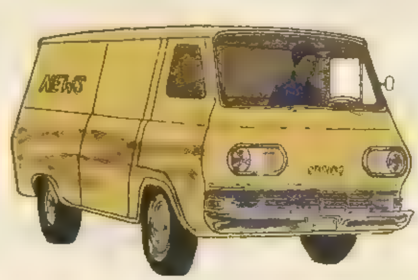
Through Investigation. Invert a child's tricycle and a bicycle, and choose groups of children to investigate the way in which each moves when the pedals are turned. Ask the children to find out why the front wheel of the tricycle turns only once for each turn of the pedals (most tricycles do not use gears). On a bicycle, however, the gears make the rear wheel turn several times for each turn of the pedal wheel.

Through Key Concept Words. Add *gears* to the Science Vocabulary Chart. Explain the word as a kind of wheel that has teeth, and demonstrate with the gears on a bicycle or on an egg beater or hand drill.

Through Activity. Collect tools and toys that use gears. Arrange the objects where children can manipulate them. Rotary egg beaters are especially interesting. Note that the teeth may be on the face of the wheel, as on one wheel of the egg beater. Let the children count the number of times the blades turn for each time the handle is turned.



Which does more work?



LESSON 7, page 17

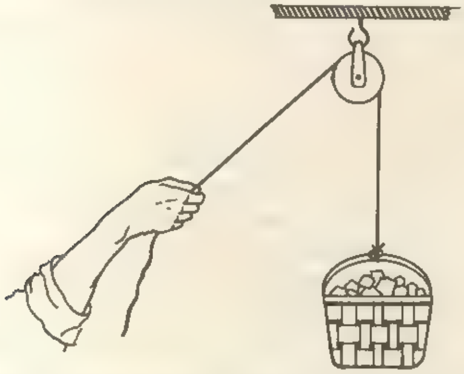
SUBCONCEPT: The rate at which energy is supplied determines the rate at which work is done.

Aim of the Lesson

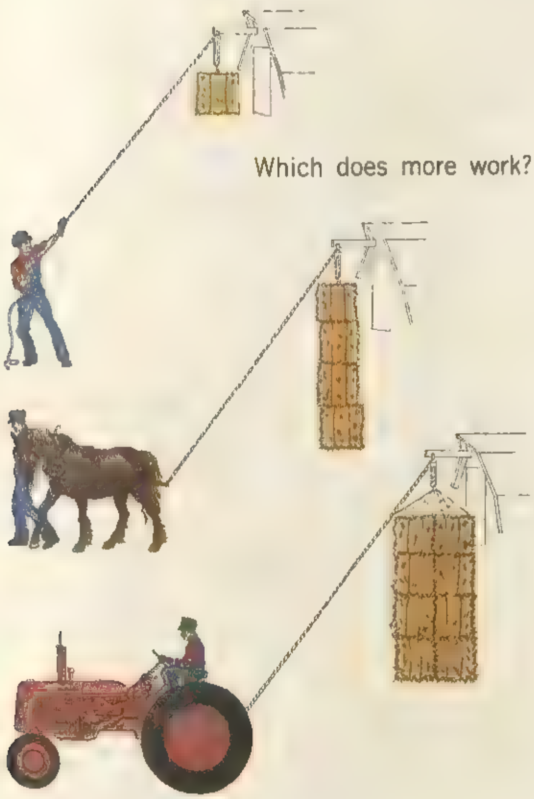
To reinforce the concept that any work requires energy; that more work can be done when more energy is used.

Introducing the Lesson

REQUIRED: two single pulleys, one fastened to a hook above the chalkboard; a ten-foot length of stout twine through the pulley; a basket loaded with blocks.



Present the items above with the basket unattached, and ask the children if they can figure out a way to make the basket go *up* by pulling *down* on the rope. Choose a child to tie one end of the twine to the basket, and have him raise the basket by pulling down on the other end. Tell him to lower the basket slowly so that it doesn't bounce or tip over.



Give the children the second ***pulley*** to examine. Ask them if they know what it is called. Call attention to the wheel, and explain that ***pulling*** down on one end of the twine makes the wheel turn and the basket go upward.

Does it take energy to lift a load even when a pulley is used?

Developing the Concept

(by emphasis on the subconcept)

1. As children study the top picture on page 17, ask where the energy is coming from to lift the bale of hay.

2. Ask about the sources of energy being used in the second picture as compared with the first picture. Then direct attention to the question on the page. **Which does more work?**

As the children respond, help them to be aware of the following:

In the top picture, one man, using his own energy, pulls on the rope and lifts *one* bale of hay.

In the middle picture, a horse pulls on the rope and lifts *four* bales.

More work is done in the middle picture and more energy is being used.

3. Now call attention to the bottom picture on the page. Ask whether more bales are being lifted by the tractor than by the man; than by the horse. Note that the same rope and the same pulley are being used in all three pictures, but the number of bales being lifted and the amount of energy being used are different.

Ask which is doing more work, the horse or the tractor; the tractor or the man. Help the children to explain their answers in terms of more energy being used when the tractor does the work. During the discussion, ask: **What is the source of energy for the tractor?**

Evaluate the children's understanding of the concept of more energy doing more work by asking them to make choices in the following situation:

Pretend that you are a farmer. You have a big field to plow. **Which of the following would you use?**

A plow that you push by yourself; a plow pulled by a tractor; or a plow pulled by a horse.

Explain fully the need for a source of energy and that a greater amount of work is done when a greater amount of energy is used. Also explain that the man, the horse, and the tractor can each do work *faster* by using more energy per unit time.

Extending the Concept

Through Investigation. Repeat the experience of using a pulley to lift a basket of blocks. Then remove the twine from the pulley, and let children take turns raising the basket by pulling the twine over the top of a door or the back of a chair. Let them discover that it is harder to lift the basket without a pulley than with one.

Through Key Concept Words. Add *pull, pulling,* and *pulley* to the Science Vocabulary Chart.

Through Language. Encourage children to tell short stories to accompany pictures collected for a child-made science book for which the class might select a title.

UNIT TWO: MOVING FASTER

Section 4: Summary and Evaluation

CONCEPT SUMMARY
Energy must be used to do work. The more work done the more energy is required. The rate of doing work is determined by the rate at which energy is used.

LESSON 8, page 18

Aim of the Lesson

To present new situations for children to interpret by applying what they have learned about energy.

A New View of the Concepts

REQUIRED: four 1-pound boxes of sugar.

Let children lift one, two, three, and four 1-pound boxes of sugar (to the same height in each case). Ask the children such questions as: **How much more energy is needed to lift two boxes of sugar than is needed to lift one? For three boxes? For four?**

Display the Science Vocabulary Chart, and pronounce the words with or for the children. Call on individuals to explain the key words on the chart. Understanding, rather than formal definition, is important at this stage. Where appropriate, encourage them to demonstrate as well as tell about word meanings.

While reviewing the key words, the children will inevitably review basic concepts from the lessons in Unit One and Unit Two.

Fixing the Concepts

Guide children in the analysis of each pair of pictures on page 18. Call on individuals to explain the content of each picture. Then ask questions which will help to organize and summarize the children's understandings. Below are questions suggested for each pair of pictures:

A. **Which way of moving leaves is easier? Why? Which is faster? Why? Where does the energy come from?** (Answers should relate to the importance of wheels in overcoming friction; less energy is required with wheels than without them.)

B. **Which way of turning over the soil is faster? Why? Where does the energy come from when the farmer digs with a shovel? When he uses a tractor? Which way uses more energy? Which is doing more work?**

C. **Which way of mowing the lawn is faster? Why? Where does the energy come from in each case? Which uses more energy, the girl pushing the hand mower or the power mower moving itself?**

Now, make a quick check to see that the children have an understanding of the following concepts and ideas:

It takes energy to make things move.

We get energy from various sources: food, fuel, electricity, wind, moving water.

When something is dragged, friction results; the use of rollers or wheels greatly reduces the amount of friction. The less friction, the easier it is to move something.

When more energy is available, work can be done faster. When more energy is available, more work can be done.

Evaluation

Through an Oral Word Game. Say each of the following open sentences, and call upon a child to supply the final word. Only four words are required for the responses.

1. We can play because food gives us **energy** .
2. It takes more energy to drag something than to move it on **rollers or wheels** .
3. Because a tractor has more energy than a horse has, a tractor can do more **work** .
4. When we make something move, we use **energy** .
5. The soles of our shoes wear out because of **friction** .

Through a Word-Recognition Game. This may be a good time for the children to begin associating their oral responses with the printed word. To do this make a large vocabulary card for each of the words required for the game.

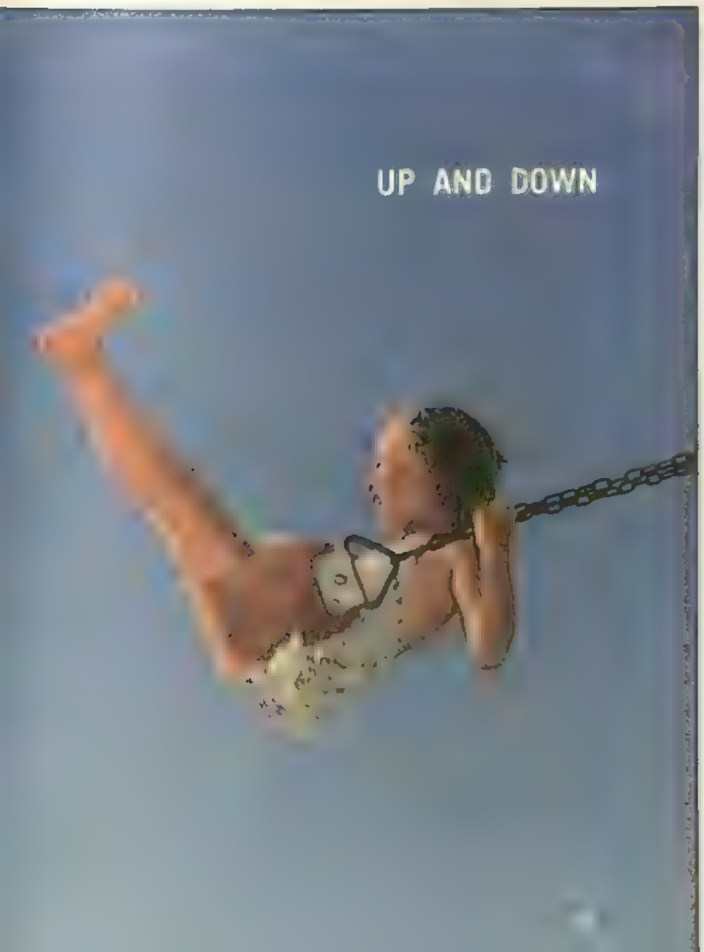
UNIT THREE: UP AND DOWN

[illegible]

Children experience the force of gravitation even though they may not be aware of it, may never have heard the word *gravity*, and do not know the meaning of *force*. They fall often and see many things fall. They go down slides, coast down hills on sleds, on roller skates, and in wagons. They step up onto a diving board and dive or drop down into the water. They are also familiar with the idea of weight. They have all been weighed and have seen meat being weighed in stores. They know that some things weigh more than others.

Children do not quite grasp the nature of the action of an "invisible" force; therefore, it is necessary to explain why things fall to the Earth. Otherwise, later on, children may not quite understand the need to exert a force opposing gravity when work is done (objects are lifted). Furthermore, it is exceedingly important to give children early experience in the art of explanation (the art of theorizing). Thus they try to explain why energy must be expended to overcome forces acting against an opposing pull. For this very important reason, experience with magnets (magnetic force) is included here to give children experience with a *force they can feel.* Gravity cannot be felt easily; it is inferred. Magnetic force can be felt and hence can be interpreted as being "real."

Many children are also familiar with magnets. They play with magnetic toys, and see magnets on bulletin boards and in use at home. Through experiences in kindergarten, some children learn that magnets can pick up some certain things and not others. They will now be able to build upon previous experiences as they explore further the forces about them.



The Conceptual Scheme is the same as that for Units One and Two (see page 1). The two subconcepts in Unit Three are as follows: Energy must be used in order to lift things against the pull of gravity; and magnetic pull (force) can be used to lift things against the pull of gravity.

Gravitational Force. The idea that things were held on the Earth by a pull, known as the pull of gravity, was understood long before the time of Sir Isaac Newton. But people did not know that this pull extended beyond the Earth. However, about three hundred years ago, this famous English scientist extended the idea of mutual attraction between objects to everything in the Universe — the Sun, the Moon, and the stars, as well as the Earth. This was indeed startling, as people had thought of heavenly bodies as quite distinct and different from earthly things.

The pull of Earth's gravitational force (on Earth it is commonly called gravity) is downward, toward its center. *Down*, then, is toward the center of the Earth; *up* is away from the center of the Earth. The Earth's gravity causes things to fall toward the center of the Earth and also holds rocks, soil, plants, animals, water, air, and people, and all the things we make and use, to the Earth's surface.

How hard the Earth's gravity pulls on an object is measured by weighing the object. Weight, then, is a measure of the pull of gravity on a given object.

The amount of attraction between two bodies is also dependent on the distance between them. The farther apart they are, the less attraction there is. As a rocket leaves the Earth, it is subjected to less and less of the Earth's pull.

When a jet takes off or when a rocket rises from its launching pad, another principle discovered by Newton is demonstrated: For every action, there is an equal and opposite reaction. Gases, pushing out in one direction, cause the jet or rocket to move in the opposite direction. The action-reaction law need not be taught to children at this point, but it is well to have it in mind when explaining the upward-moving balloon in Lesson 5 (page 25 of the textbook).

Magnetic Force. The complete explanation of magnetic forces is not yet known. When the word *force* is introduced, explain that force is an amount of push or pull.

All magnets, for reasons not clearly understood, attract certain metals, particularly iron. Since magnets exert force that can lift certain objects, they can be used to overcome the force of gravity. When a magnet lifts something, it is evidence that the pull of this particular object is great enough to overcome the force of gravity on that object. When a magnet cannot lift an object, it is evidence either that the magnet exerts no force on this particular object or that the magnet's force is not great enough to overcome the force of gravity on that object. The reason for introducing magnetic force here should not be misunderstood. Magnetic forces are not gravitational forces. They are introduced here to help children understand the concept of force.

UNIT THREE: UP AND DOWN

Section 1: Gravity

CONCEPT
Energy must be used to do work. Work is defined as a force acting through a distance.

LESSON 1, pages 20 and 21

SUBCONCEPT: Energy must be used to do work against the pull of gravity.

Aim of the Lesson

To provide various experiences by which children begin to understand that gravitational force pulls things toward the center of the Earth.

Introducing the Lesson

REQUIRED: a large ball.

Choose children to take turns tossing the ball straight up. Let them see how high they can make the ball go. Ask them to watch the ball as you toss it up and to find out exactly what the ball does after it is tossed. They will see that the ball goes up, stops, and then comes down. Repeat the experience several times until the class is ready to consider these questions:

What makes the ball go up? Why does the ball stop going up? What makes it come back down? The children have learned what makes the ball go up, but most of them will have to make up answers to the other questions. Tell them that the lesson will help them to answer the other two questions.

Developing the Concept

(by emphasis on the subconcept)

1. Have the children look at the picture on page 20. Tell them that it is a picture of Isaac Newton. According to a well-known story, something is happening in the picture that focused Isaac Newton's thoughts and investigations on the problems involved in falling bodies. **What did Isaac Newton see falling from the tree?** Then explain to the class what is happening by telling the story of Isaac Newton. The following is a simplified version.

Isaac Newton lived about 300 years ago on a farm in England. Even as a little boy, he was curious about all sorts of events on ***Earth.*** He made kites and flew them to find out about the energy of the wind. He invented a little windmill and used it to grind wheat. He made a sundial and studied sunshine and shadows. He learned about many things by doing investigations.

At the age of fourteen he had to leave school because his mother needed him to work on the farm. Young Isaac was not a very good farmer, though, because he was always thinking about why things worked the way they did — and the things he wanted to investigate. A few years later, his uncle sent him away to college, where he studied hard and was happy learning many of the things he wanted to know.

When Isaac was 23, he returned to his home on the farm. One day he was in the orchard, drinking a cup of tea and thinking of the things he had studied in college. Suddenly an apple fell to the ground — or so the story goes. Isaac began to think about the falling apple. He knew that nothing begins to move unless something makes it move. He wondered about things that fall and why they always fall *down,* toward the Earth, and never up. He realized something pulled the apple straight down to the Earth.

Newton began to think and work intensely on the problem. Especially, he wondered why the Moon did not fall to the Earth. He discovered that just as the Earth's gravitational pull affected objects on Earth, so the bodies in space affected the Moon. He found out how the Earth pulls on apples and on everything that is on the Earth. This pull is called the pull of ***gravity.*** The Earth's pull is toward the center of the Earth.

Newton became world famous. He received many honors for his work. Scientists, today, still depend on the discoveries that Isaac Newton made. His discoveries extended into many areas — mathematics, gravitation, optics.

2. Encourage children to discuss the story freely and to look again at the picture. Call attention to the fact that even when Isaac Newton was a little boy, he wondered about the

things that moved and changed, and he learned about them by doing investigations.

Invite children to tell about things they have seen fall. Through discussion, bring out the fact that things always fall *down* and that down means toward the center of the Earth.

Have each child feel the pull of gravity by holding his textbook on one hand with arm extended. All of them will discover that they cannot hold the books up for very long. Ask them not to drop the books on the floor.

3. Now direct attention to the pictures on page 21. Call on different children to tell what is going to fall or come down, what is coming down, and what has already fallen. Ask them to explain why these things are happening or have happened. Help them to analyze each picture and see that, once objects are not held or supported, they fall. Encourage children to explain falling as being pulled down toward the center of the Earth by gravity.

At an appropriate time, read the question on page 21 with or to the children. Ask them to use the word *gravity* in their answers.

Conclude the lesson by referring back to the two final questions in the introduction to the lesson:

Why does the ball stop going up?

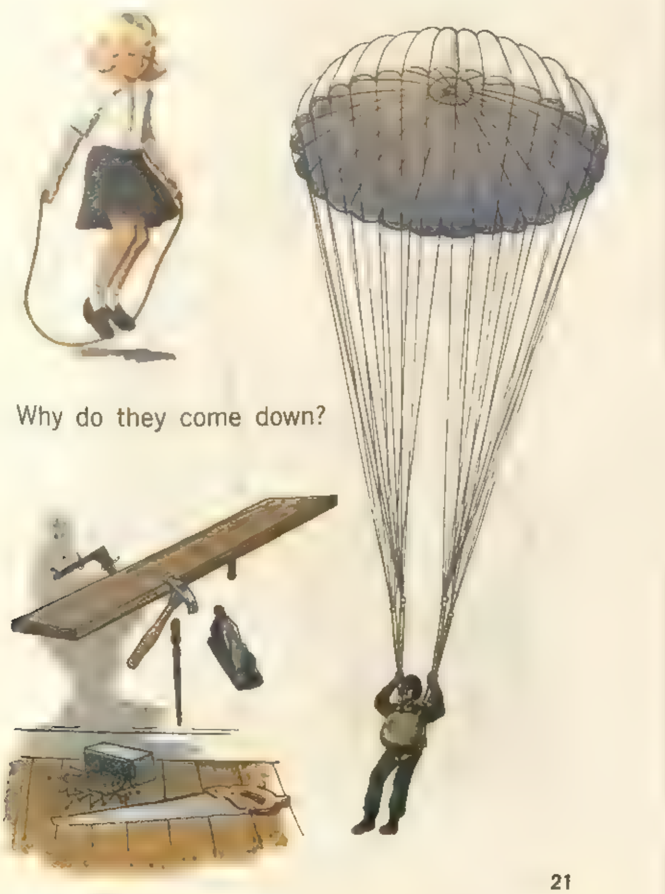
What makes it come back down?

In answering the questions, children will reveal their understanding of the pull of gravity by giving the following explanations:

Gravity pulls on the ball and makes it stop going up.

Gravity then pulls the ball down toward the center of the Earth.

Energy was used to make the ball go up.



Why do they come down?

21

For further evaluation of the children's comprehension, ask these questions:

What happens when a fireman slides down a pole in the firehouse?

What happens when the trunk of a tree is chopped off at the ground?

What happens when the bottom of a power shovel full of rocks is opened?

Encourage children to give reasons for their answers and to explain in terms of the pull of gravity.

Extending the Concept

Through Activity. Let the children use a classroom globe and toy planes to show that when a plane goes up it goes away from the center of the Earth: when it comes down, it goes toward the center of the Earth. Have them demonstrate flights from the southern hemisphere as well as from the northern.

Through Key Concept Words. Add *gravity* and *Earth* to the Science Vocabulary Chart.

LESSON 2, page 22

SUBCONCEPT: Energy must be used to do work against the pull of gravity.

Aim of the Lesson

To give children experience in using their energy to lift themselves against the pull of gravity (gravitational force).

Introducing the Lesson

REQUIRED: a small chair.

Select several children to come forward one at a time. Then, while you hold the back of a chair, have the same children jump up onto the chair and then jump down to the floor. Ask whether it is harder to jump up or to jump down. **Why is it harder to jump up than to jump down?**

Developing the Concept

(by emphasis on the subconcept)

1. Have the children study the pictures on page 22. Choose children to tell the story that is illustrated. Suggest to the children that the kitten rolled off the stool. Ask why it fell to the floor and not to the ceiling. Encourage explanations that include the pull of gravity toward the center of the Earth. (The term "force" will be introduced in Lesson 3.)

Then ask other children why the kitten did not have to stay down on the floor as in the third picture. **How did it get back up onto the stool?** When the children state that the kitten stepped up or jumped up, have them recall their own experience in getting into and out of the chair. Have them tell what the kitten had to use to jump up and what was pulling the kitten down. In jumping, it worked against gravity. Ask how else the kitten might have been able to get back into the chair. **Could someone have lifted it up?** The idea here is that energy from some source is needed to work against gravity and make the kitten go up. Lead the class to these assumptions:

Gravity pulls the kitten down toward the center of the Earth.

When the kitten jumps up, it uses its own energy to work against gravity.

When someone lifts the kitten, that person uses his energy to work against gravity.

Recall the experience of jumping off and onto the chair and the question that resulted: **Why is it harder to jump up than to jump down?** By now, at least some of the children will be ready to generalize as follows:

It is easy to jump down because gravity pulls us down. It is hard to jump up because we have to work against gravity. It takes energy to jump up.

2. Near the close of the lesson, have the children again look at the textbook while you read aloud the questions on the page. By now, the children should give answers such as: Gravity pulls it down, or gravity makes it fall, and energy is used to make it go up.

To make a further check of understanding, present a new situation for discussion. Here is an example:

An airplane, like everything else on and near the Earth, is pulled on by gravity. But an airplane can rise off the ground, go up high, and stay up for a long time. **How can an airplane do this when gravity is pulling on it?**

Through discussion, encourage children to explain that the plane uses energy from fuel when it rises from the ground and when it stays in the air. If someone says that planes sometimes fall, stress the role of gravity in pulling a plane to the ground. Apply this to rockets also.

Extending the Concept

Through Investigation. Use small baskets (Easter baskets are good) with rubber bands fastened to the handles. Let children put objects with various weights into the baskets and suspend them by the rubber bands. The effect of the pull of gravity can be observed as the rubber bands are extended. Recall previous investigations with rubber bands (Unit Two) in which the children found that a rubber band is stretched more by a big pull than by a small one. They will now see that gravity exerts more pull on some things than on others.

Through Safety. Discuss the dangers of falling, and ways in which falls can be prevented. Suggest that children check their own safety habits in this respect. **Are they always careful about climbing? Do they keep skates and other toys where no one will fall over them? Do they follow school safety rules when using slides and other playground equipment?**

Through Art. Suggest that children make safety pictures to warn of the danger of falling. Use the pictures for a display headed, "Gravity Can Make Us Fall."

Why does it fall?
How does it get up?

LESSON 3, page 23

SUBCONCEPT: Energy must be used to do work against the pull of gravity.

Aim of the Lesson

To give children further experience in using their energy to raise an object against the force of gravity.

Introducing the Lesson

REQUIRED: an unbreakable, nonbouncing toy such as a rag doll or stuffed animal.

Choose children to drop the toy from different heights. Discuss why it goes down. Bring out the fact that the person who drops the toy is not using energy to make it go down. After each drop, have someone come forward and pick up the toy. Ask whether the toy could get up by itself. Lead the discussion toward these questions:

Why do we not have to use our energy when we drop something? Why do we have to use energy when we lift something?

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: a container of water; a glass.

1. Direct attention to the milk-pouring sequence in the textbook. Let the children explain why the milk goes down into the glass rather than up to the ceiling or over to the wall. Choose a child to pour water from a container into a glass to show that water, like the milk in the picture, flows down when it is poured. Ask the children to think of *two* ways in which they could get milk from a glass up to their mouths. They will suggest using energy by lifting the glass with their hands or by sucking (lifting) the milk up through a straw. (Do not attempt to explain suction at this time.) Emphasize the fact that energy must be used to make the milk go up.

2. In the bottom row of pictures, the children see another familiar scene. Help them to explain why the girl must hold onto the books. Then ask whether the books will go up to the shelf if she lets go of them. **How can she get the books onto the shelf?** Some may suggest a stool or a stepladder, which illustrates self lifting also. Help them to see that the girl is pushing upward on the books and is using energy to raise them up.

Direct attention to the two questions on the page, and help the class to read them. Encourage answers that explain the downward movements in terms of gravity and the upward movements in terms of energy being used to lift or raise.

Next, introduce the term ***force***, and explain the meaning in terms of function: gravity pulls things toward the center of the earth; we call this pull the *force of gravity*. The only way to make something go up is to push or pull until we overcome the force of gravity; such pushing or pulling is also a *force*. When we raise something we use such a force.

3. Summarize the lesson by leading the class into a discussion of the following situations:

A very young bird fell down out of its nest. It was too young to fly. **Could it fall back into the nest? How could it be returned to the nest?**

A little boy said that his shoe once fell all the way up the stairs. **How do you know that this could not happen?**

Encourage children to explain their answers in terms of the force of gravity and the need for another force to overcome it in order to make anything go up.

Extending the Concept

Through Arithmetic. Introduce a spring balance or a kitchen scale, and explain that we can find out how hard gravity pulls on something by weighing it. ***Weight*** is a measure of gravity's pull. Let children ***weigh*** sugar in one-, two-, and five-pound cartons. Help them to see that the pull of gravity is greatest on the five-pound carton. Then let them investigate gravity's pull on miscellaneous objects by weighing them.

Through Investigation. Choose several children to lift objects in the classroom. Let them discover that a desk or table, which one child cannot lift, can be lifted by three or four children using their combined energy. (Do not have children strain at lifting.) From this, lead the class into a discussion of the need for enough upward force to overcome the downward force of gravity if something is to be lifted.

Through Key Concept Words. Add *force* to the Science Vocabulary Chart. Add *weight* and *weigh* if the arithmetic, above, has been used.

With Rapid Learners. Ask them to find out whether or not rivers ever flow uphill.

Why does it go down?

What makes them go up?

LESSON 4, page 24

SUBCONCEPT: A force can be used to counteract another force.

Aim of the Lesson

To help children establish the concept that the force of gravity can be overcome only by a force acting against it.

Introducing the Lesson

REQUIRED: a basket; a number of heavy blocks or other heavy objects.

Place the basket on the floor, and choose a child to lift the basket first when empty, then with a few blocks, and finally with a number of blocks. Ask him in which case it seemed harder to lift the basket and in which did he need the harder pull. Choose other children to repeat the investigation with the basket empty, with only a few blocks, and heavily loaded. Let them experience differences in pull required to lift things of various weights.

Why are some things harder than others to lift?

Developing the Concept

(by emphasis on the subconcept)

1. Call attention to the picture at the top left on page 24. Have the children show with their hands what the child is doing. Discuss the use of spoons and forks to ***lift*** food from plate to mouth.

2. Then refer to the picture on the right, and ask what the farmer is lifting with his pitchfork. Present the problem of whether the fork or the pitchfork could lift anything by themselves. Through discussion, lead to the realization that the child and the farmer are using energy to lift. Ask why the food and the hay cannot go up by themselves.

When the downward pull of gravity is mentioned, ask what is pulling upward, against the pull of gravity. The children will then see that in lifting, a force is exerted that acts against the force of gravity. **Which force is pulling upward, the force of gravity or the force the child is using? Which force is pulling upward when the forkfuls of hay go up?**

3. Next, have the group study the picture at the bottom of the page. Even if children do not recognize a steel girder, they will realize that something very heavy is being lifted; they will see that a machine is doing the lifting. Ask whether a man could lift a steel girder. Encourage the children to explain their answers in terms of gravity's pull on the girder, which is greater than a man's pull in lifting. Help them to understand that the machine can pull hard enough against gravity to lift the heavy girder. **Which has more force, the machine or the man? Which do you think uses more energy — the farmer lifting hay or the machine lifting the girder?**

Through further discussion of things we can lift and things that are too heavy for us to lift with our own force, lead the children to these assumptions:

We can overcome the force of gravity on some things when we lift them.

We cannot lift things when the force of gravity is stronger than our force.

Machines are used to lift some things that are too heavy for people to lift.

To determine the degree of understanding of one force overcoming another, present the following problems, acting them out as you present them:

When I pick up this book, what two forces are acting on it? Which force is overcoming the other? When the book falls, what force is acting on it?

I try to lift this desk, but I cannot do it. **Which force is stronger, my lifting force or the force of gravity?**

Children will show their comprehension by reasoning, in each instance, that the stronger force wins out.

Extending the Concept

Through Art. Suggest that children make pictures showing different things being lifted: elevators, people on an escalator, furniture into a truck, baggage into a plane, snow on a shovel, etc.

Through Key Concept Words. Add *lift* to the Science Vocabulary Chart.

Through Arithmetic. Using the scale in the nurse's office (or a bathroom scale provided for the purpose), weigh each child, read the weight, and help him to make a record of his weight. Explain that each child's weight is a measure of the pull of gravity on him.

What lifts it up?

24

LESSON 5, page 25

SUBCONCEPT: A force can be used to counteract another force.

Aim of the Lesson

To help children to understand that the upward push on a rocket is caused by gases being pushed downward by the rocket.

Introducing the Lesson

REQUIRED: information (and perhaps pictures on a bulletin board) about a recent space exploit or rocket ascent. A film may be used.

Get children to volunteer to tell some of the things they know about ***rockets.*** One or more in the class may have obtained some information from a parent or other relative who is involved in space industry or research. Most children will have seen rockets on television programs. Perhaps you will wish to discuss a recent space exploit with the class. Lead into the lesson with the question:

Who can tell what makes a rocket go up? Repeat aloud any answers, such as an *explosion, fuel, energy,* etc. Then suggest: Let's see if we can find out what makes a rocket go up.

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: oblong balloons of various sizes and colors. (Blow up the balloons several times before class to expand the rubber.)

What makes it go up?

25

1. Tell the children to look at page 25. They will see at once that some sort of an investigation is to be done and that balloons will be used. Help them to recognize the word **Investigation.** Print it on the board and have the children say it several times.

2. Now blow up one of the balloons. Hold it neck down, and have children suggest what will happen when you let go. Do not comment on any of their predictions, but pose the question: **How can we find out?** When they say to let the balloon go and watch what happens, refer to the operation as doing an investigation.

When the children observe that the balloon goes off, up, and sideways before it falls, suggest a repetition of the investigation with different balloons to find out if they do roughly the same thing. After several balloons have been observed zooming hither and thither, refer to the question on page 25: **What makes it go up?**

Ask whether anyone is moving the balloon. To help them understand what happened, ask how the balloon changed *after* it was released. **What happened to the air in the balloon?**

To prevent any misinterpretation of what happens, you will probably need to give a short explanation, such as the following: When the neck of the balloon is released, the air rushes out, and the balloon moves in the opposite direction. The principle developed by Newton is: every action results in an equal and ***opposite*** reaction. There does not have to be anything under the balloon. (NOTE: The balloon could be in a vacuum.)

Choose children to repeat the investigation, using a fresh balloon for each child. Have each one explain why the balloons "take off." Then ask whether the force of gravity is pulling on the balloons. They can see that the balloons fall after the air has left.

3. Summarize the investigation by calling on children to tell what happens when a balloon goes up (or moves about) and when it falls. Help the class to reach these assumptions:

> When air rushes out of a balloon, the balloon moves in the opposite direction.
>
> When there is no more air rushing out of the balloon, gravity pulls the balloon down.

4. Next, direct attention to the picture of the rocket in the textbook, and ask children how it is pushed up off its launching pad. They will see the downward rush of flaming gases and will reason that the rocket is pushing the gases down, so the gases are pushing the rocket up.

Extending the Concept

Through Activity. Collect pictures of rockets and use them for a bulletin board display.

Through Key Concept Words. Add *push, rocket,* and *opposite* to the Science Vocabulary Chart.

Through a Visiting Lecturer. Invite a parent or other friend involved in the science or technology of rockets to visit the class and discuss rockets.

UNIT THREE: UP AND DOWN

Section 2: Magnetic Force

CONCEPT
Force is used to counteract force.

LESSON 6, page 26

SUBCONCEPT: Magnetic forces can be used to overcome the force of gravity.

Aim of the Lesson

REQUIRED: a box of paper clips: a bar magnet of sufficient strength to lift a string of clips.

Without showing the magnet, scatter some paper clips on a table and on the floor. Ask children if they can think of ways in which the paper clips might be picked up quickly. (Don't be surprised if you get some ingenious ways.) Introduce a magnet, whether or not it is mentioned. Choose children to come forward and use it to pick up the clips. See what sort of responses you get to the question.

Can a magnet pick up all kinds of things?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: several bar magnets: two empty boxes, one labeled *YES* and one *NO;* a collection of miscellaneous items such as thumb tacks, paper clips, pennies, a top from a small "tin" can, a cork, stamps, seeds, rubber bands, plastic and metal toys, etc.

1. On page 26, the children see a boy and a girl doing an investigation. Print the word ***magnet*** on the chalk board and say it. Then help the children to read the question on the page, **What can a magnet lift?** Explain that they are now going to do the investigation, similar to the one in the picture, to find the answer to the question.

2. Scatter the miscellaneous items across a table, and give the magnets to several children. Let them use the magnets to find out which can be lifted. Have them put the things that the magnets lift into the *YES* box and the others into the *NO* box. After all of the items have been placed in the boxes, review the contents of the *YES* box with the children. Ask them in what way all of the things in the *YES* box are alike. If the children do not use the word ***metal,*** introduce it by describing the items as "a metal paper clip," "a metal can top," "a metal nail," etc. Now have the children tell which things in the picture belong in the *YES* box.

3. Then review the contents of the *NO* box, and note that there are some metal things in the *NO* box. Lead to the discovery that magnets lift only some kinds of metals, mainly ***iron*** and ***steel,*** which is made from iron. Refer the children again to the picture of the investigation and have them tell which things belong in the *NO* box. Get them to state reasons for the choices they make.

(NOTE: If desirable, emphasize that work is done by application of a force. Ask: **How do you know that a force is acting on the clips?** Help the children to realize that the force of gravity is acting in one direction while the magnetic force acts in the opposite direction (when an object is lifted).

Extending the Concept

Through Investigation. Let the children use a bar magnet to lift a string of paper clips. They will discover that the magnet makes each clip act as a magnet to pick up the next one. Let them see how long a chain one magnet can hold up (when the force of gravity overcomes the magnetic force), and what happens when they take the top clip off the magnet. This illustrates quite simply temporary magnets.

Through Key Concept Words. Add *magnet, metal, iron,* and *steel* to the Science Vocabulary Chart.

Through a Game. Cut out paper fish and color them. Fasten a paper clip to the mouth of each. Put the fish into a large open box. Using magnets on strings, let children take turns lifting the fish from the box. You may wish to use one or two fish without clips.

Through Arithmetic. Label each fish "1 point," "2 points," or "3 points." Have each child keep track of his score by getting the total number of points; or have teams with a score keeper.

What can a magnet lift?

LESSON 7, page 27

SUBCONCEPT: The greater the force, the greater is the amount of work done.

Aim of the Lesson

Children recognize that when a magnet lifts, its force is great enough to overcome the force of gravity.

Introducing the Lesson

REQUIRED: top cut from small "tin" cans; several small empty "tin" cans; several that are filled and heavy; a strong magnet.

Have the children use the magnet to lift the small pieces of metal, and to try to lift the empty and full cans. They will find that some can be lifted by the magnet and some cannot, though they will feel a magnetic attraction each time the magnet is brought near to or is touched to the metal. Lead into the lesson with the question:

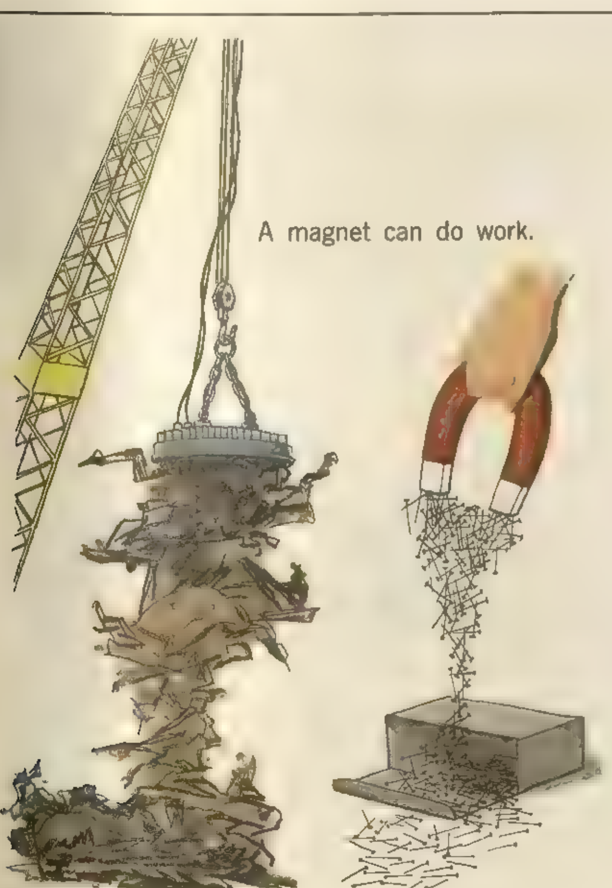
Why can the magnet pick up some pieces of steel and not others?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a bar magnet on a string; a paper clip.

1. Direct the children's attention to the left-hand picture on page 27. Ask what the crane is doing with the heavy scrap metal. Ask what holds the metal to the end of the crane. The children will see that the scrap is not tied to the crane and that there are no hooks or other devices grasping the scrap.



A magnet can do work.

27

From their experience in lifting with magnets, they will reason that a magnet is holding on to the scrap metal.

To show how this may be done, bring out the paper clip and the magnet on the string. Have children take turns holding the string and lowering the magnet to pick up the paper clip. Each time the clip is picked up, ask someone to pull it off the magnet so that the demonstration may be repeated.

Then present the problem of how the heavy scrap metal in the picture is pulled off the big magnet. Help the children to understand that, in order to lift the heavy metal, the magnet must have a very strong pull—much too strong for a person to overcome by pulling against it.

At this point, explain that the magnet used on the crane can be "turned on and off" by electricity. After the scrap is in the desired place, the electricity is turned off, and the magnet loses its force. The scrap is released. When the magnet is lowered over more scrap, the electricity is turned on again, and the magnet can again lift.

Recall the children's experience in using a magnet on light and heavy cans. Ask why the magnet they used could not lift the heavy cans. They will show their understanding of the need for a strong force to lift heavy things by responding that the magnet they used is not a strong magnet. It does not have enough force to overcome the force of gravity that pulls down on the heavier cans.

2. Conclude the lesson by directing attention to the right-hand picture on the textbook page. Ask the children to explain how the actions in the two pictures are alike and how they are different. Help them to express the following ideas:

Both magnets are lifting things made of steel.

The big magnet has enough force to lift heavy scrap metal.

The little magnet has enough force to lift steel pins.

Both magnets overcome gravity when they lift.

The big magnet can be "turned on and off" by electricity; the little magnet cannot.

The greater the force, the greater is the amount of work done.

Extending the Concept

Through Investigation. Use magnets and paper clips to discover that a magnet can exert a pull through certain substances. For example: a piece of paper, a sheet of glass or the side of a tumbler, a cloth handkerchief, a sheet of aluminum foil.

Through an Exhibit. Use a bulletin board and/or a shelf to display a three-dimensional exhibit of things that are and are not attracted by magnets.

Through Key Concept Words. Review the words on the Science Vocabulary Chart. When you come to the words that have been added during Unit Three, have children show or act out the meanings whenever possible.

UNIT THREE: UP AND DOWN

Section 3: Summary and Evaluation

CONCEPT SUMMARY
Energy must be used to do work. Work is done against the force of gravity when a force is applied in the opposite direction.

LESSON 8, page 28

Aim of the Lesson

To give children an opportunity to interpret new situations by applying their understanding of energy as used in relation to forces acting on objects.

A New View of the Concept

REQUIRED: a globe of the Earth; a toy airplane; small plastic figures of people or cars.

Use the globe and the toys to demonstrate the direction in which the Earth's gravity pulls. Call on children to show a car or a person on the surface of the Earth in the United States and in Australia. Review *down* and *up* and let the children see that, anywhere on the Earth, down is toward the Earth's center and up is away from the Earth's center. At any point a person stands with his feet down and his head up. The car in Australia does not fall off the real Earth because *up* is away from the Earth's center. Let a child show how a plane takes off and flies around the Earth. Review the plane's use of energy to lift itself from the Earth's surface.

Fixing the Concept

1. Read the caption, "THE BIG IDEA," as the children look at page 28. Explain that they are going to have a chance to tell about the big idea of gravity in explaining the things that are happening in the pairs of pictures.

2. Call on pupils to tell what is happening in each picture and why it is happening. Encourage answers that relate to the downward pull of gravity, the use of energy from some source to do work against gravity, and the use of magnetic force to overcome the force of gravity. The following questions, relating to each picture, may be useful in guiding the discussion.

What makes the plane go up?
What makes the capsule with the parachute come down?
What makes the arrow go up?
Does it keep on going up?
What makes it come down?
What holds the pins up?
Why do they fall?

3. Invite children to tell of and demonstrate things they have done that required them to lift, jump, push, or pull against the force of gravity. Mention some of your own experiences, such as lifting snow or soil with a shovel, climbing up a ladder, pushing shut the upper half of a window, etc.

By now, the children should have a clear understanding of the following concepts and subconcepts:

The Earth's gravity is a force that pulls down, toward the center of the Earth.

To make anything go up, some force must push or pull against the force of gravity with a greater force.

When a magnet lifts something or holds it up, the magnet uses a force against the force of gravity.

Extending the Concept

Through a Word Game. Write *magnet* and *gravity* on two cards. Stand the cards in the chalk tray. Then use ten or more questions similar to the following, and have children choose the card that provides an answer to each question.

1. **What can lift a paper clip but not a rubber band?**
2. **What makes water run down hill?**
3. **What keeps us from jumping as high as the roof?**
4. **What can pull against gravity on some things but not on others?**

Through Investigation. Use a board as an inclined plane and a roller skate with rubber band attached. Let children pull the skate up and down the slope, by means of the rubber band. By observing the stretch of the rubber band, they will become aware of the difference in amount of energy needed to overcome friction and to do work against the force of gravity.

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UNIT FOUR: HOT AND COLD

CONCEPTUAL SCHEME
When matter undergoes a chemical change, the total amount of matter remains unchanged.

Children have seen ice cubes melt in a warm room, puddles dry in the sun, butter melt on hot toast, and chocolate candy become liquid in their hands. Many have experienced freezing and melting with the change of seasons.

While they already know that heat causes things to change, their information is probably not yet organized in relation to any major concepts. They know that ice melts, but they do not yet see that this is an example of *solid changing to liquid* — a broader concept that brings together, in a pattern, many seemingly different changes. As with the study of energy (Units One, Two, and Three), the study of matter will involve the children in investigations and other activities and will enable them to use many of the experiences of their daily lives to discover some of the patterns of change in the world about them.

The Conceptual Scheme. The materials of which the universe is composed are called **matter**. Matter has weight and occupies space. It is easy to recognize things we can see, such as rock, metals, wood, water, etc., as having the characteristics of matter. Air, however, is also matter. The fact that it is an invisible substance does not alter the fact that it has weight and takes up space. Heat, light, sound, and electricity, on the other hand, are not classed as matter, but as forms of energy.

When a substance burns, it is not annihilated; it is changed to an invisible gas which mixes with the other invisible gases in the air. In other words, when matter changes into another form of matter, no matter is lost or gained, destroyed or created.

Before the discovery of atomic energy, it was believed that the only thing that could be done with matter was to change from one form of matter to another. Now we know that matter can be changed into energy and energy can be changed into matter. But again, there is no actual unbalance, matter becomes energy, and energy becomes matter. The total amount of matter and energy remains unchanged.

The subconcepts in Unit Four are that matter exists in various forms and states and that energy from the sun causes changes in matter.

The Three States of Matter. Matter may be solid, liquid, or gas. Each of these states has its specific characteristics.

A solid has its own shape. It keeps this shape unless it is changed by some action, such as cutting, striking, heating, or growing.

A liquid has no shape, but takes the shape of the part of the container that holds it.

A gas has no shape of its own, also. When a gas is put into a container, it spreads out and takes the shape of the entire container.

Changing from One State to Another. Energy in the form of heat can cause matter to change from one state to another. When a solid is sufficiently heated, it changes to liquid. When enough additional heat is applied, the substance changes from liquid to gas. Heat, then, causes matter to change its state from solid to liquid, and from liquid to gas. Loss of heat causes change of state in the reverse order: from gas to liquid, and from liquid to solid.

It is the gain and loss of *heat* that cause the change of state. *Cold* is not a form of energy; *cold* is merely a descriptive term applied to a substance that has lost heat or that has less heat in comparison with another substance. Hence, it is not *cold* but *loss of heat* that causes water to freeze.

The Sun is the Earth's chief source of heat energy. Heat from the Sun melts glaciers, icebergs, frozen lakes and rivers, and the ice cubes in a pitcher of lemonade; it evaporates water from the ocean and from the soil and dries the washing on the line. These things happen as heat causes water to change from solid to liquid or from liquid to gas. When sufficient heat is lost, the gas (water vapor) changes back to liquid (water); if enough additional heat is lost, the liquid freezes into a solid (ice).

UNIT FOUR: HOT AND COLD

Section 1: Solid, Liquid, Gas

CONCEPT
Matter exists in various forms and states.

LESSON 1, page 30

SUBCONCEPT: Matter may exist as solid, liquid, or gas.

Aim of the Lesson

To help children become aware of characteristics of three substances (rock, water, air) that are typical of the three states of matter.

Introducing the Lesson

REQUIRED: a paper fan and a bowl of water.

Choose two children to come forward. Use the fan to make a breeze against the cheek of one. Dip the hands of the other in water. Ask each child to tell what he feels. Help children to become conscious of differences among the substances that surround them. Ask the children to tell about some of the different kinds of things they have seen or touched today. Encourage each one to describe the items in terms of their shape and how they feel when they are touched. Pose the question:

What are some of the ways in which things are different?

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: three empty plastic bags, some rocks, a cupful of water, an empty bowl.

1. Direct attention to the question on the pupil's page 30: **What is in the bag?** Read the question, or choose a child to read it. Then call on individuals to tell what each child in the top picture is holding in the plastic bag.

If bags, ***rocks***, and water are at hand, bring them out now, and choose three children to represent those in the picture.

CAUTION: Do not blow up the plastic bag; inflate it by sweeping the open bag through the ***air***. See suggestion for safety at the end of the lesson.

Let the children in the class feel as well as look at the bags. Help the children to compare the contents of the three bags and describe how each bag looks and feels and the shape of each. Emphasize *shape*, and lead to these observations:

The rocks have roundish shapes with some edges on them.

The water is shaped like the bottom of the bag.

The air fills the bag.

2. Next, ask the class to study the picture of the first child emptying the bag (bottom of page) and to find out what happens to the shape of the rocks.

Choose someone to describe what happens to the water when it is emptied into the bowl. If convenient, have a child pour a small amount of water into a bowl.

Now, ask how anyone can tell that the air has gone out of the third bag. Lead to the discovery that once the air is out of the bag, they cannot tell where it is. Help the children to summarize the following ideas in their own words:

Rock, water, and air are three different kinds of things.

Rock is solid, and has its own shape. You can lift it and put it down and it keeps the same shape.

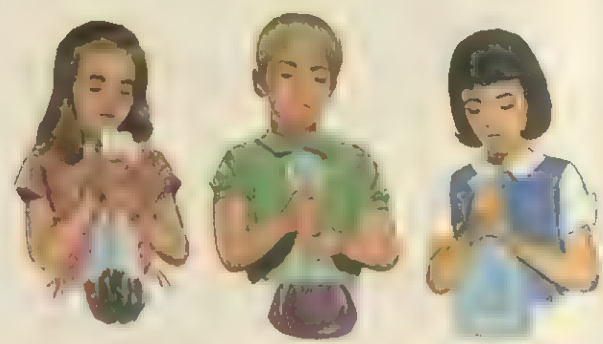
Water does not have a shape of its own. When you pour it, it spreads out and takes a new shape.

You can feel air, but you cannot see it. When it is in a bag, it fills the bag. You cannot tell what happens to the air when it goes out of the bag because you cannot see air.

Extending the Concept

Through Key Concept Words. Add *air* and *rock* to the Science Vocabulary Chart.

Through Safety. Use an empty plastic bag to show how easily it clings to your hands. Explain that it will also cling to the face, covering the nose and mouth and keeping out air. Caution children against playing with plastic bags, including the ones used to cover clothing that comes back from the dry cleaner. Urge children also to keep such bags away from younger children.



What is in the bag?

LESSON 2, page 31

SUBCONCEPT: Common forms of matter may exist as either a solid, liquid, or a gas.

Aim of the Lesson

Using as examples rock as a solid, water as a liquid, and air as a gas, children may discover that substances exist as solids, liquids, or gases.

Introducing the Lesson

REQUIRED: three plastic bags, some rocks, water, an aquarium or large jar with water in it.

Fill the bags as shown on page 30. Choose three children to come to the front and hold the bags for all to see. Through discussion of the content of each bag, review the main characteristics of the rocks, water, and air as developed in Lesson 1 (that is, rocks are hard and hold their shape; water is wet and takes the shape of the bottom of the container; air fills the container). Have the children empty the three bags, being careful not to spill the water. Encourage them to discuss what happens to the air when it leaves the bag. Pose the question:

Can you think of some way to remove the air so that you can see that the air is leaving the bag?

Developing the Concept

(by emphasis on the subconcept)

1. Read the question on page 31. After the children have answered that the bags contain rocks, water, and air, call on a child to describe how the children in the picture are emptying their bags. Have someone tell what happens to the rocks. **Do they keep their shape when they are in the water?**

2. Choose someone else to describe what happens to the water when it is emptied into the tank. **Does it keep its shape?** (It mixes with the water that is already there.)

3. Then ask the entire class to study the picture of the bag of air being emptied. **Is the air going out of the bag? How do you know? Where is the air going?** Guide the children to recognize the bubbles as evidence that air from the bag is going into the water and is rising to the top. Ask where they think the air goes when it reaches the top of the water. Lead them to the assumption that the air mixes with the other air in the room.

4. You may wish to review the picture on page 30 showing that the bag that contained air is now empty and help children to understand that the air also mixed with the other air in the room. Since there were no bubbles, however, the children could not see that air was leaving the bag.

5. Explain now that rocks, water, and air are three different *kinds* of things; each kind has a special name.

Write ***solid*** on the board, and explain it as something (like a rock) that has its own shape and keeps its shape wherever it is. Invite children to name other things that are solids. If the object named is in the classroom, have the child touch it or show it when it is named. Let children place some small solids on a table.

Write ***liquid*** on the board, and explain it as something (like water) that has no shape of its own. It takes the shape of the part of the container that holds it. When it is not held in something, it spreads out. It can be poured, and it feels wet. Call on children to name other liquids.

Write ***gas*** on the board, and explain it as something (like air) that has no shape of its own. It spreads out and does not lie on the bottom of a container, but takes the shape of the whole of the thing that holds it. If nothing holds it, it just spreads out and has no shape at all. Explain that air is really different kinds of gases, all mixed together. We cannot see them, taste them, or smell them. But we can smell some kinds of gas, like the kind we burn in a stove.

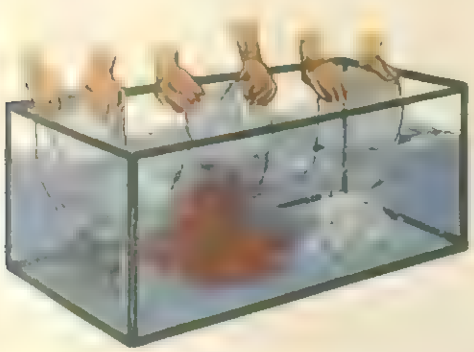
6. Ask the children if they can think of a single thing that is not a solid, nor a liquid, nor a gas. Help them to reach the conclusion that all the things around them are either solid, liquid, or gas. Now they know something more about the nature of matter.

Extending the Concept

Through Activity. Collect items for an exhibit of solid, liquid, and gas substances. Use pictures as well as real objects, particularly for liquid and gases.

Through Key Concept Words. Add *solid, liquid,* and *gas* to the Science Vocabulary Chart.

With Slow Learners. Give them balloons to inflate and then to empty under water. Help them to identify the air in the balloons and bubbles in the water as gas; the water as liquid; and the balloons and the container that holds the water as solids.



What is in the bag?

solid liquid gas

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UNIT FOUR: HOT AND COLD

Section 2: Water Changes State

CONCEPT
Matter exists in various forms and states.

LESSON 3, page 32

SUBCONCEPT: The state of matter can change.

Aim of the Lesson

To give children the opportunity to discover that a solid substance can change to a liquid, and vice versa.

Introducing the Lesson

REQUIRED: a tray or pitcher filled with ice cubes.

Call on children to handle the *ice* cubes and tell how they feel. Help them to identify the ice as solid. Encourage them to tell of personal experiences with ice (in the refrigerator, in lemonade, or outdoors on a winter day). If there is a sunny spot in the room, place the container of ice in the sun. If there is no sun, place it in some warm area.

What will happen to the solid ice cubes?

Developing the Concept

(with emphasis on the subconcept)

1. Direct attention to the top picture on page 32, and ask where the *ice* cubes came from. Through discussion, bring out the fact that the ice was taken out of the cold part (the freezer compartment) of a refrigerator. In mentioning ice, refer to it repeatedly as *solid*.

2. Choose a child to tell what is going on in the second picture. Help to bring out the fact that something *solid* has been placed on the fork (also a solid).

3. Direct attention to the third picture, and ask what is dripping from the fork. Guide the children to the realization that the drops are *liquid*.

4. Next, have the class study the fourth picture and find the answers to these questions:

What happened to the ice that was on the fork?
What is now in the glass?
Where did the water come from?
What changed?
Why did it change?

Encourage children to explain their answers in terms of the ice (a solid) changing to water (a liquid). Explain that when something ***melts,*** it changes from solid to liquid.

Invite children to tell about things they have seen melt. As they mention ice cream, popsicles, snowmen, butter, chocolate, or other substances, help them to point out that the changes were from solid to liquid form.

Check the children's comprehension of the process of change through melting by referring again to the pictures on the page. This time ask what ice is made of. Establish the idea that ice is frozen *water* — water in solid form. Then ask the class to decide whether the water in the ice cube disappears, changes from solid to liquid, or runs away.

Conclude the lesson by choosing a child to get the container of ice cubes that was used in the introduction (see above). Let all the children see what is happening inside the pitcher or tray. Then guide them in formulating a summary, in which the following ideas are expressed in their own words:

Ice is water in solid form.

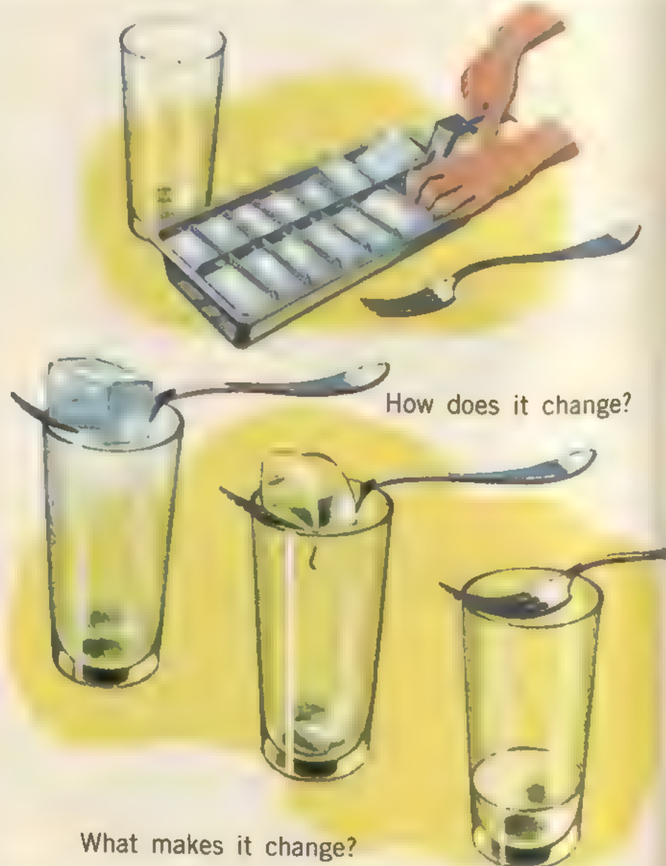
When ice melts, it changes from solid to liquid.

Extending the Concept

Through Investigation. Let each child dip his fingers into the melting ice cubes in the container used in the lesson. Leave the container with the melting ice in the room all night. The following day have the children again dip fingers into the container to discover how much warmer the water feels now that all the ice has melted.

Through Key Concept Words. Add *ice* and *melt* to the Science Vocabulary Chart.

With Rapid Learners. Ask children to bring in small amounts of materials that will melt (change from solid to liquid) when left in a warm place. Provide aluminum foil pans for the materials: butter, candle wax, chocolate candy, shortening, gelatine. Such substances will melt (at least partially) over hot water, in warm sunshine, or on a warm radiator.



How does it change?

What makes it change?

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LESSON 4, page 33

SUBCONCEPT: Heat energy can be used to change a solid to a liquid.

Aim of the Lesson

Children explore and discover that heat causes ice, a solid, to change to water, a liquid.

Introducing the Lesson

REQUIRED: a thermometer (preferably red alcohol) in a cup of cold water; a cup of warm water.

Call on individuals to use their fingers to feel the cold water in the first cup, then to feel the warm water in the second cup. Have them tell which feels warm and which cold. Let the children look at the ***thermometer*** in the cold water and see where the red line (or the mercury column) ends. Now ask if anyone can tell what will happen if the thermometer is put into the second cup. After some suggestions have been made, place the thermometer in the second cup, and let the children watch the column rise. Guide them to the discovery that the rising of the column happens because the water in the second cup is warmer than that in the first cup, and that the higher column means "warmer."

Developing the Concept

(by emphasis on the subconcept)

1. As you call the children's attention to page 33, explain that the pictures show an investigation that was done with a thermometer. Call on children to describe everything they see in the first picture. Help them to identify the ice cubes as solid, to note that the red line is not very high on the thermometer (meaning "cold"). Note the time as nine o'clock in the morning.

2. Direct attention to the second picture and ask whether the glass has been placed in a warm or a cold spot. **What does the thermometer show?** If there is a spot of sunshine in the classroom, let children feel the difference between being in the sun and in the shade. If there is no sunshine, discuss sun and shade on hot summer days to establish the fact that the Sun makes things warm.

3. Call on someone to describe the third picture. Ask the class to find two things that have changed. In what way has the ice changed? In what way has the line on the thermometer changed? Help them to be aware of the changing of water from solid to liquid form by ***heat,*** and the difference in the height of the column on the thermometer while standing in the tumbler and in the sun. The clock face indicates the passage of time.

At this point, refer to the experience with a thermometer in the introduction to the lesson, and help them to recall that the line on a thermometer is higher when the thermometer is in a warm place than when in a cold place. Through further discussion, lead children to the following assumptions:

The thermometer in the picture shows that the sunlit windowsill was much warmer than the ice.

The ice was heated by the Sun.

When the ice was heated, it changed to water (changed from solid to liquid).

It takes heat to make ice change to water.

To evaluate the success of the lesson, present the following problem for discussion:

Suppose that we had three trays of ice cubes and we put them in three different places: one in the freezer compartment of a refrigerator, one on a hot stove, and one outside in the shade. **In which one would the ice melt first? In which would it melt next? In which would it not melt at all? How do you explain this?**

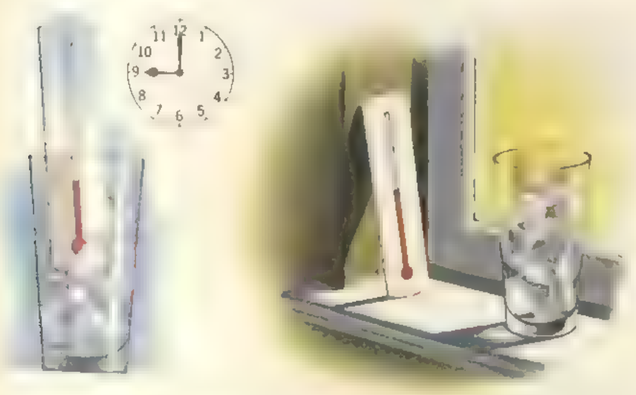
Encourage answers that show an understanding of heat being used to change ice to water, the more the heat the faster the change.

Extending the Concept

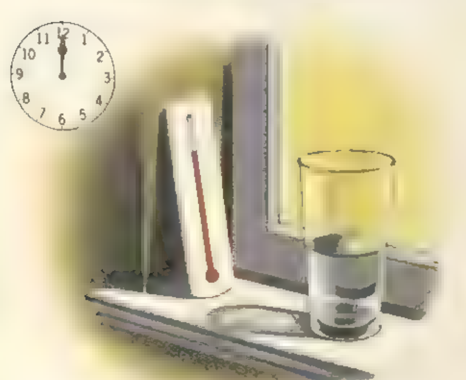
Through an Investigation. Present two pans, each containing a few pieces of ice. Ask what will happen to the ice if the pans are left in the room. Ask how the ice could be made to melt faster. Place one pan in direct sunlight on the windowsill and one in the shade to demonstrate the fact that more heat can speed up the process of change from solid to liquid. Keep a record of the time required for the melting of the ice in each pan.

Through Key Concept Words. Add *thermometer* and *heat* to the Science Vocabulary Chart.

Through Activity. Give children dime store thermometers to explore with, watching the columns rise and fall as the thermometers are applied to ice water, cold and warm water from the faucet, a jar of sand or soil from the playground, the water in the aquarium, etc.



What makes it change?



LESSON 5, page 34

SUBCONCEPT: Heat energy is given off when a liquid changes to a solid.

Aim of the Lesson

To help children discover that loss of heat causes water, a liquid, to change to ice, a solid.

Introducing the Lesson

REQUIRED: a refrigerator ice cube tray filled with water (liquid).

Introduce the tray, and let the children see that it is filled with water instead of ice cubes. Explain that when you took the tray out of your refrigerator yesterday, it was filled with ice cubes. Let them explain why the ice melted. Now ask what you would have to do to make the water in the tray change back to ice. When they explain that you would put it back in the freezing compartment, ask:

What makes water (a liquid) change to ice (a solid)?

Developing the Concept

(with emphasis on the subconcept)

1. Call on children to tell the story of the first picture on page 34. Through discussion of what is being done, help to bring out the essential details: water is being poured into a plastic drinking "glass"; the high red line in the thermometer shows that the water is warm; and it is evening.

2. Have the children study the second picture to find out what is being done with the glass of water and the thermometer. Ask about the particular place in the refrigerator where the jar and the thermometer are being put. Encourage children to tell about refrigerators at home and the kinds of things that are kept in the freezer compartments. Call attention to the red line on the thermometer. Let the children predict whether the line will go up or down after the thermometer has been in the freezer for a while.

3. As children study the third picture, call attention to evidence that the time is the following morning, and explain that the glass has been in the freezer all night. Choose individuals to tell what they think will have changed during the night.

4. Have them verify their predictions by looking at the fourth picture. They will see that the water changed to ice. The red line on the thermometer went down. Encourage them to see that the line went down by comparing the thermometer in the bottom pictures with the one shown in the top pictures.

Ask whether water gets hotter, or colder, when it changes to ice. Point to the thermometer in the second picture and explain that the *water* is warm — it has plenty of heat. Then point to the thermometer in the last picture and explain that the *ice* is cold — it has *lost heat*. Help children to see that *getting cold* means *losing heat* and that the water *lost heat* when it was in the freezer. As the water lost heat, it changed to ice, its solid form.

To reinforce the idea of water *losing heat* in the freezer, present the following questions in sequence:

Did the water get warmer when it was put into the refrigerator?

Did it stay as warm as it had been in the room?

Did it lose heat in the refrigerator?

How do you know it lost heat?

Encourage children to give reasons for their answers and to use the pictures of the red line on the thermometer as evidence for their answers. Then, through further discussion of the pictures, lead the children to this understanding:

When water loses enough heat, it changes to ice.

Check for understanding by asking questions about the following:

Melting ice cream and ice cream in the freezer: butter in the refrigerator and butter on hot toast.

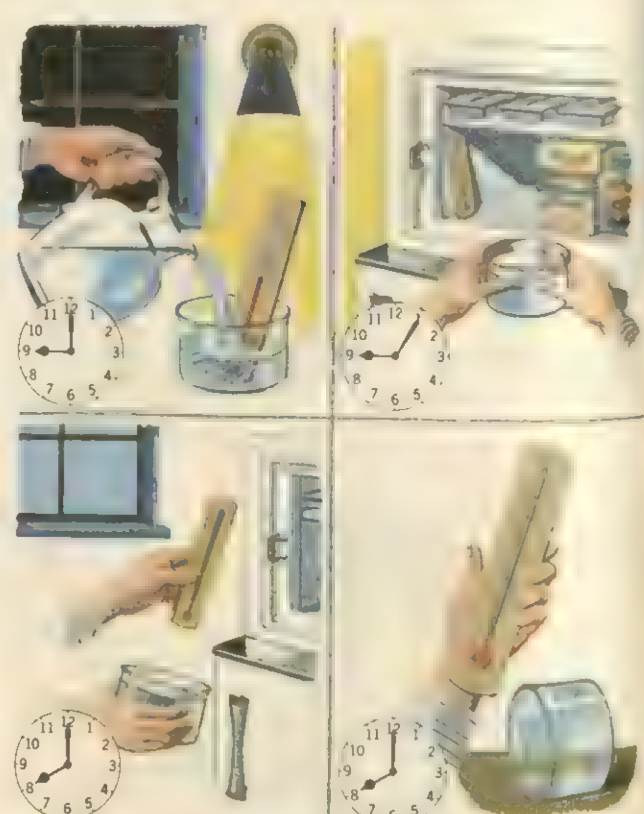
Extending the Concept

Through Activity. Provide cups containing a mixture of ice and water. Let children use thermometers to discover that the melting point of ice is indicated by the tops of the red lines a little above the 30 marks on the scales. Move thermometers from the cups of melting ice to cups containing cool and warm water and watch the "columns" rise.

Through Arithmetic. Teach ***degree*** as a unit of measure on a thermometer. Then, using a large chart or drawing of a thermometer, let children tell (by counting, adding, or subtracting) the number of degrees hotter or colder as you indicate the column moving from 30 to 40; 60 to 70; 60 to 50; etc.

Through Key Concept Words. If the arithmetic activity above is used, add *degree* to the Science Vocabulary Chart.

Through Art. Collect and make pictures showing liquids in cans, bowls, rivers, ponds, tumblers, etc. Use them with a caption: **What can make them change to solids?**



What makes it change?

UNIT FOUR: HOT AND COLD

Section 3: Measuring with a Thermometer

CONCEPT
Matter exists in various forms and states.

LESSON 6, page 35

SUBCONCEPT: Matter changes in state as the temperature changes.

Aim of the Lesson

To give children experience in the use of a thermometer to measure changes in temperature.

Introducing the Lesson

REQUIRED: a thermometer chart or drawing of a thermometer on the board; at least one thermometer.

Indicate on the chart the position of the top of the liquid column in the real thermometer. Choose a child to come forward and show which way the column moves when it gets warmer and when it gets cooler. Use both thermometer and chart to establish the fact that, when the column is higher, it indicates a higher temperature than when the column is lower. Temperature is a measure of hotness (not of amount of heat). Discuss the use of thermometers to indicate how warm it is outdoors.

Where is it hotter?
Why is it hotter?

35

Where does the heat come from outdoors to make the column in the thermometer move up?

Developing the Concept

(with emphasis on the subconcept)

REQUIRED: two outdoor thermometers, preferably identical.

1. Direct attention to the strip across the top, and call on individuals to identify the word and explain the meaning of this signal that an investigation is to be done.

2. Have the class study the picture and then tell how the two thermometers are being used. Bring out that the investigation is being done outdoors, that one thermometer is around the corner from the other, and that one is in the sunlight and the other is in the shade.

Next, read the first question, or call on a child to read it: **Where is it hotter?** Suggest that everyone look carefully at the picture for a way of explaining his answer.

As soon as the class has agreed that the side of the building where the thermometer column is higher is hotter than the other side, present the second question: **Why is it hotter?** From personal experience, most children will reason that the sunny side is hotter than the shady side.

Now pick up the two thermometers in the classroom, and ask children how an investigation like the one in the picture could be done outdoors. Find places in sun and shade (inside and outside), perhaps on a classroom window ledge where the thermometers can be easily observed.

Present the word ***temperature*** as a measure of how hot something is. Lead into a discussion of how thermometers are used to tell temperature, indoors and out, and help the children to arrive at these understandings:

We use a thermometer to find the temperature.

Heat makes the line, or column, on a thermometer rise. The higher the line, the higher the temperature.

Heat from the sun makes the temperature go up.

3. Direct attention to the pictures on the bottom of page 35. Ask which pictures represent the colder place and which the hotter place. Then ask the children to name all the things that indicate a winter scene and a summer scene.

Extending the Concept

Through Activity. If there is a thermostat in the room, let the children examine the thermometer on it. Then let them discover, through discussion, that heat from some source (heater or furnace, which uses fuel) causes the temperature to rise.

Through Key Concept Words. Add *temperature* to the Science Vocabulary Chart.

Through a Long-Term Activity. Begin a daily record of outdoor temperature. Make readings each day in the same place and at the same hour. At first, you may need to assist the children in reading the scale.

Through Art. Suggest making pictures showing what we do and what we wear in hot weather (to permit loss of heat) and in cold weather (to prevent loss of heat).

UNIT FOUR: HOT AND COLD

Section 4: Water Changing from Liquid to Gas

CONCEPT
Matter exists in various forms and states.

LESSON 7, page 36

SUBCONCEPT: When liquids evaporate, gases are formed.

Aim of the Lesson

Children observe the evaporation of water; observation helps them to understand evaporation as a change in state from liquid to gas.

Introducing the Lesson

REQUIRED: Chalk board, wet sponge, paper fan.

Show the wet sponge to the class. Squeeze out a few drops to establish the fact that there is water in the sponge. Then choose a child to come forward and use the sponge to make a wet spot or strip on the chalk board. Ask the class what will happen to the wet spot. As the children watch the spot get smaller and disappear, make certain that they appreciate that this happens because the water is disappearing. Now make two separate wet spots on the board. Have a child fan one spot to make it dry faster. Then ask:

What happens to the water as the wet chalk board gets dry?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a sponge, water, and a glass.

1. As children look at page 36, choose a volunteer to explain the things contained in the strip at the top of the page.

Choose another child to tell what is to be done in the investigation. Use the wet sponge to squeeze ten drops of water into the glass. Let the class count the drops as they fall into the glass. Next, call attention to the word above the picture: "Monday." Help the children to understand that the sign indicates that the investigation in the picture began on Monday.

2. Ask what will happen to the water if the glass is left in the room. Then have children look at the picture to find out what happened to the water in the investigation shown on the page. Then call attention to the word "Tuesday," above the picture. Present the question:

What happened to the water between Monday and Tuesday?

Ask how they can find out what will happen to the ten drops of water when left in the glass in the classroom.

As soon as someone suggests leaving the glass alone until tomorrow, place the glass in a sunny or warm spot.

3. Introduce the word ***evaporate.*** Explain that the ten drops of water in the glass *evaporated.* It changed to a gas called ***water vapor.*** The children may be interested in discovering the word *vapor* in evaporate. We cannot see water vapor because it is an invisible gas. When water changes to water vapor, it goes into the air.

By the close of the lesson, the children should have the following understandings:

When water evaporates, it changes to water vapor.

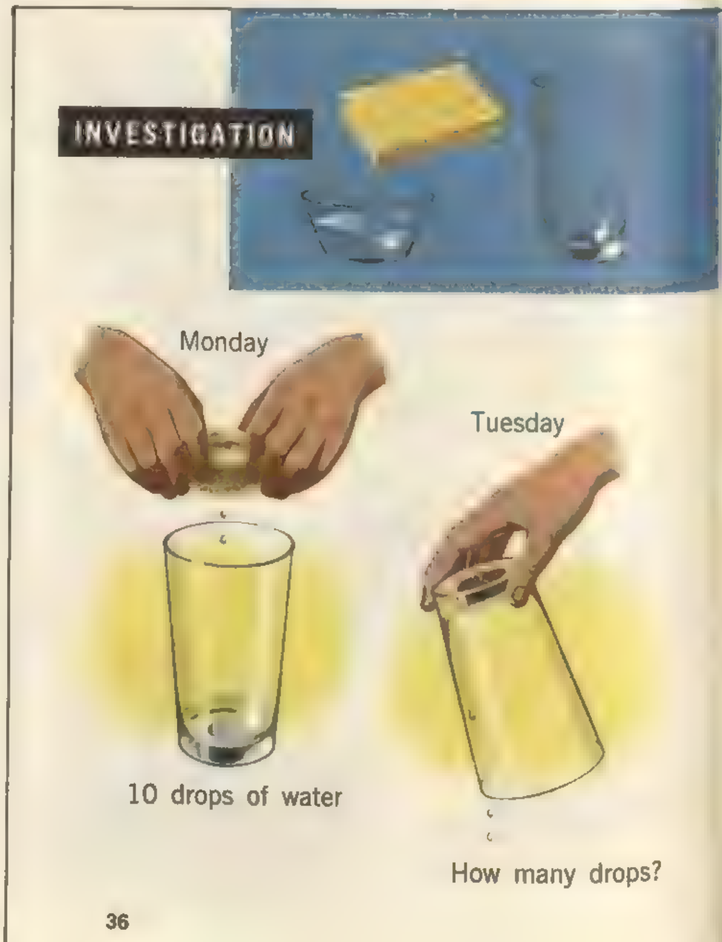
When water evaporates, it changes from liquid to gas.

The water vapor goes into the air; we cannot see water vapor.

Extending the Concept

Through Key Concept Words. Add *evaporate* and *water vapor* to the Science Vocabulary Chart.

Following up the Investigation Begun in the Lesson. On the day following the teaching of Lesson 7, have the children check the glass to find out whether or not the ten drops of water have evaporated. Continue to check until the glass is perfectly dry. Compare the time required for the evaporation of ten drops of water in the classroom and in the investigation pictured in the textbook. If there is a significant difference, encourage children to speculate as to a reason for the difference. (Water evaporates faster in a warm place than in a cold one. However, in humid air, air that already contains considerable water vapor, water evaporates less readily than it does in dry air.)



LESSON 8, page 37

SUBCONCEPT: Heat energy is needed for evaporation to occur.

Aim of the Lesson

To give children the opportunity to discover the relationship between heat energy and evaporation.

Introducing the Lesson

REQUIRED: Two identical glass jars with large openings.

Put about one inch of water into each of the two glass jars. Mark the water level on each jar with a piece of tape. Leave the jars uncovered.

Show the jars to the children, pointing out the water level marks. Ask the children to help you choose the warmest place and the coolest place in the room. Put a jar in each place.

Now pose the question: **From which jar will the water evaporate faster?**

Developing the Concept

(with emphasis on the subconcept)

1. Help children to read the question on page 37. Point out the two pictures in each row. In each picture, something wet is getting dry. In one picture in each row, some thing is drying faster than in the other picture. Guide children's reasoning as they explain why something dries faster under one condition than under another condition. Discuss the effect of more heat versus less heat on the speed of drying.

Row 1. **Which mittens will dry first, the ones far from the fire or the ones near the fire? Why will those that are nearest to the hot fire dry faster? Why will the other mittens dry more slowly? Will they ever get dry?**

Row 2. **Will the clothes dry faster in the hot sun or in the shade? Why will they dry faster in the sun? Will the clothes in the shade get dry? Why will they dry more slowly?**

Row 3. **Which wet towel will dry first, the one hanging on the towel bar or the one that is being ironed with a hot iron? Why does ironing something make it dry faster?**

2. Develop the idea of heat being used to dry things by inviting children to tell about various things they have observed getting dry: hair under a drier, dishes in a dishwasher or on a drying rack, clothes in a clothes drier, a porch or sidewalk after it has been hosed off, etc.

Through discussion of the pictures and of the children's personal experiences with drying, help establish the following understandings:

Heat makes wet things get dry.

More heat makes them dry faster.

Now ask what happens to the water — as the things get dry, the mittens, the clothes on the line, and the towel, (pictures on page 37).

Help the children to understand that the things shown in the picture get dry because the water evaporates. They already know that when water evaporates, it changes from liquid to gas (water vapor) and goes into the air.

Refer to the investigation that was started in the Introduction, and ask if anyone now wishes to change his original prediction.

3. Through discussion, guide children to the following understandings, expressed in their own words:

Heat causes water to evaporate.

Wet things become dry by evaporation.

Consider the lesson successful if the children understand that heat makes water evaporate (or change to a gas) and that drying is due to evaporation.

Extending the Concept

Through Investigation. Put one inch of water into each of two identical jars. Use a piece of tape to mark the water level on each jar. Cover one jar tightly, and leave the other jar uncovered. Place both jars in the warmest place in the room. Let the children discover in which the water evaporates. Give them opportunity to explain the reason for the difference in evaporation.

With Rapid Learners. Moving air apparently causes faster evaporation, as demonstrated by "fanning" the wet spot on the chalk board in Lesson 7. Have the children discuss reasons for this speed-up in evaporation — more air is passing over the area, so more heat is being provided.

Through Arithmetic. Review the temperatures recorded on the daily temperature chart. Discuss rising and falling temperatures in terms of heat from the Sun. You may need to help in this arithmetic, unless the children already have used two-digit numerals.

UNIT FOUR: HOT AND COLD

Section 5: Summary and Evaluation

CONCEPT SUMMARY
Matter exists in various forms and states. Changes in the state of matter are determined by heat.

LESSON 9, page 38

Aim of the Lesson

To give children an opportunity to interpret new situations by applying their understanding of the relationship between heat and changes in the state of matter.

A New View of the Concepts

REQUIRED: an outdoor thermometer.

Help the children to read and record the outdoor temperature. Recall that the freezing point is 32 degrees (or "a little above the 30 mark"). Ask whether the air outside is warmer or colder than freezing. If the temperature is at or below freezing, have the children tell of places where they have seen ice on the way to school. If the temperature is above freezing, have them tell about water (in puddles, bird baths, pools, etc.) that they have observed in the neighborhood.

How does heat make water change outdoors?

Fixing the Concepts

1. Have children study the first picture on page 38 and describe the things they see. Call attention to the thermometer. Then ask why the ice and snow are frozen solid.

2. Have the class study the second picture. Use questions such as the following to guide their thinking:

What things have changed since the first picture was made?

What is happening to the ice and snow?

What is the ice changing to?

What is causing it to change from solid to liquid?

Where is the heat coming from?

How can you explain that it is warmer in the second picture than in the first?

3. Then, as the children review the pictures, ask the following questions:

What happened to the puddles of water that came from the ice?

What did the water change to?

What caused the water to evaporate (or change from liquid to water vapor)?

Where did the heat come from that made the water change to water vapor?

Which day is the hottest? How can you tell?

Which day is the coldest? How can you tell?

Encourage answers that use the thermometer readings as well as the melting and evaporating as evidence that it is getting warmer in each successive picture. Summarize the evaluation by calling on volunteers to supply key words to complete the following statements:

1. When ice is heated, it changes to **water**.
2. When ice melts, it changes from solid to **liquid**.
3. When water is heated, it changes to **water vapor**.
4. When water evaporates, it changes from liquid to **gas**.
5. When water loses enough heat, it changes to **ice**.
6. When water freezes, it changes from liquid to **solid**.

Extending the Concept

Through Key Concept Words. Review the words on the Science Vocabulary Chart from Unit Four: *air, rock, solid, liquid, gas, ice, heat, melt, degree, thermometer, temperature, water vapor, evaporate.*

Through Investigation. Put a small dab of perfume, rubbing alcohol, or cologne on the back of each child's hand, and let the children observe what happens as the liquids evaporate. Encourage them to use their sense of smell to discover that the gas is present after the liquid has evaporated.

Through a Problem. Bring in a bottle of ginger ale and open it in front of the class. Ask children to find three different solids (bottle, cap, and label); one liquid (ginger ale); and one gas (bubbles).

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UNIT FIVE: CLOUDY OR SUNNY

Children learn much from their daily experiences. In their nursery rhymes, songs and games, in fact, in nearly all their activities, children are consciously involved with rain and sunshine. What they do, what they wear, and where they go are all influenced by the kind of day it is — rainy or clear.

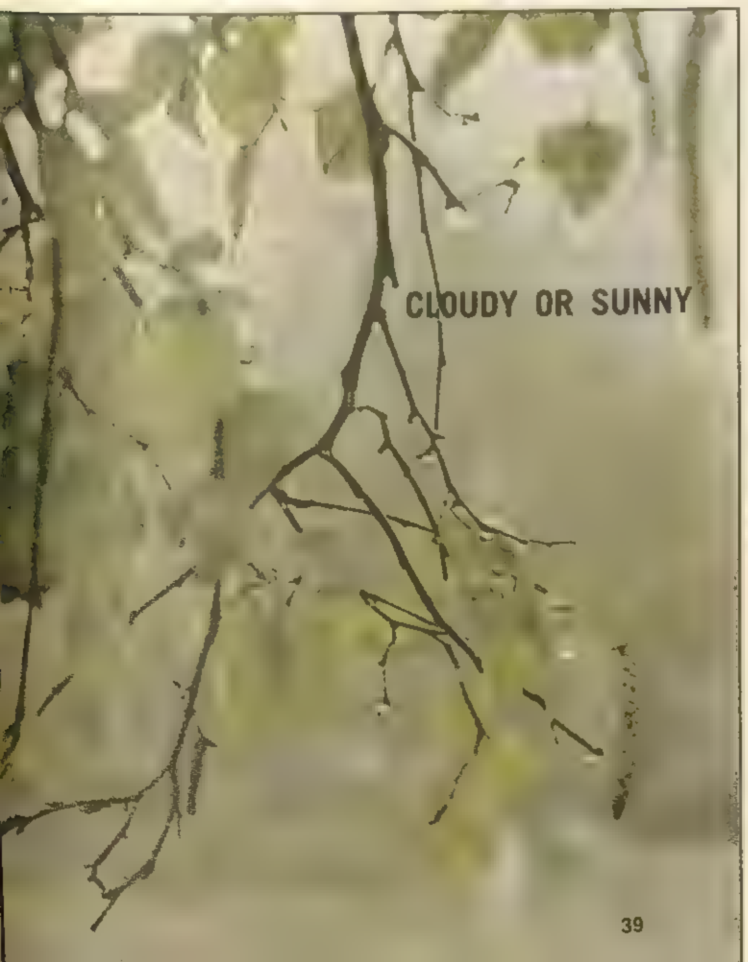
Most young children, however, have only a vague idea of the relationship between clouds and rain. In this unit, they will apply some of the concepts about matter and energy that were developed in earlier units. Such applications will help them to attain a better understanding of weather.

Content. Matter exists in three states: solid, liquid, and gas. Under certain conditions, matter changes from one state to another. Energy, in the form of heat, is required to change the state of matter.

In Unit Five, we are concerned mainly with changes in the state and form of water and with the role of heat energy in these changes. More specifically, we are interested in those changes in the state of matter that produce clouds and precipitation.

The Sun is the Earth's chief source of heat energy. It can cause ice to melt and water to change to a gas, water vapor. When enough heat is lost, water vapor changes back to water, and water to ice.

Water Vapor in the Air. Water covers a large part of the Earth's surface. The Sun, shining on the water, heats it, and changes some of it to water vapor. The water vapor, an invisible gas, goes into the air and mixes with the other invisible gases that make up the Earth's atmosphere.



Sometimes the air around us has so much water vapor in it that the effects are clearly noticeable. Damp clothes stay damp and perspiration does not evaporate; we sense a general "mugginess," or "high humidity." Things do not dry because the air already holds all the water vapor that it can.

How different it is on a dry day! Washing dries almost as soon as it is put on the line. Even if the temperature is high, we feel comfortable. Heat is being removed continuously from our bodies; it is used to evaporate perspiration.

In this unit, the main points about water vapor that need to be kept in mind are the following:

Whenever water evaporates, it is getting heat from some source. Heat is necessary for evaporation.

Water vapor mixes with the air in the atmosphere.

When water vapor *loses* enough heat, it changes back to water, that is, it *condenses*.

We may see water vapor condense to water when air containing water vapor comes in contact with a cold surface, such as that of a glass containing ice water. The air loses heat as it touches the cold surface of the glass. As the water vapor in the air cools, it condenses and leaves drops of water on the outside of the glass.

Water Vapor and Clouds. As the earth's water evaporates, water vapor moves continuously into the air. Warm air containing water vapor rises from the earth and gets cooler. It loses some of its heat. When this occurs, the water vapor changes to very small particles of water, tiny droplets that are light enough to stay up in the air. When large clusters of these droplets form, we see them as clouds.

Clouds differ, of course, in size and shape. They change and move as winds blow them across the sky. However, all clouds are alike in that they are formed from water vapor. In some very high clouds the water vapor changes to ice particles. Fog is a cloud that is on or near the ground.

Clouds and Rain. When a cloud loses sufficient heat, its droplets join together and form large drops of water. These drops are too heavy to stay up; gravity brings them down to the Earth as rain. (Gravity pulls on the droplets too, but the force is very small, and the air resists the falling.)

Some of the rain is used by plants and animals. Some of it is returned directly to the atmosphere by evaporation, using heat energy from the Sun. Clouds form, rain falls, and evaporation takes place. These things occur over and over again in a sequence of changes so important that we could not live on the Earth if they did not happen.

UNIT FIVE: CLOUDY OR SUNNY

Section 1: Clouds

CONCEPT
Evaporation and condensation are changes in the state of matter.

LESSON 1, page 40

SUBCONCEPT: Clouds and precipitation result from the cycle of evaporation and condensation.

Aim of the Lesson

To help children to understand that a cloud can be formed from water that has evaporated and gone into the air.

Introducing the Lesson

REQUIRED: a bulletin board display of pictures of clouds.

Invite children to look at, discuss, and ask questions about the cloud pictures. Take them outside (or let them stand at the windows) to look at the sky for evidence of clouds. Encourage them to tell what they know about clouds — differences in shape, color, and how they move across the sky. Lead the discussion to the question:

What are clouds made of?

Let us see if we can find an answer by considering water boiling in a teakettle.

Developing the Concept

(by emphasis on the subconcept)

1. Have children look at the picture on page 40 and describe what is happening. Refer to the water as a liquid, and ask what happens to a liquid when it is heated. Help the children to recall from Unit Four that heat can change a liquid to a gas: *heat changes water to water vapor*. When water in the kettle is boiling, it is changing from liquid to water vapor quite rapidly.

Children will wonder what it is they see coming out of the teakettle. Some, undoubtedly will say "steam." This is a popular notion, but more precisely, steam is water vapor and, therefore, is invisible.

2. At this point, call attention to the gap between the spout of the teakettle and the little ***cloud.*** Water vapor is coming out of the spout; like all water vapor, it is invisible. Have children point to the place where the water vapor is coming out of the teakettle.

3. Point out the little cloud just beyond the gap and explain as follows, how it is formed.

a. Heat changes the water in the teakettle from liquid to gas. The gas is water vapor.
b. The water vapor comes out of the teakettle spout and into the air. We cannot see it.
c. The water vapor is hot. The air around it is *not* hot. Water vapor loses heat when it touches the cool air. **What happens to water vapor when it is cooled?**
d. Since water vapor changes to water when it loses heat, the cloud must be made up of tiny droplets of water. We can see the cloud formed by the tiny droplets.

Check for understanding by asking children to respond to the following questions:

Why can we see the cloud in front of the teakettle when we cannot see water vapor?

Would there be any clouds in the sky if there were no water?

What happens to the water vapor from the teakettle to make it change to water?

Encourage answers that reveal an understanding that the cloud is formed when water vapor in the air changes to tiny droplets of water.

Extending the Concept

Through Actual Observation. Use a teakettle, water, and an electric grill to do the investigation on page 40.

CAUTION: Teach children the danger of touching the grill, the teakettle, the invisible gas coming out of the spout, and the hot cloud. Explain that a very painful and serious burn can result from touching hot things.

Do **not** let children assist in doing this demonstration.

Through Key Concept Words. Add *cloud* to the Science Vocabulary Chart.

Through Activity. Have children bring in pictures of clouds. Let them use their cutout pictures to make a chart or scrapbook of different kinds of clouds.

What makes the little cloud?

LESSON 2, page 41

SUBCONCEPT: Clouds and precipitation result from the cycle of evaporation and condensation.

Aim of the Lesson

To give children an opportunity to see that drops of water can come out of a cloud; that these drops of water can evaporate and return to the air as water vapor.

Introducing the Lesson

REQUIRED: Lesson 1 page 40, of textbook.

Review the preceding lesson by having children describe what is happening in the pictures on page 40. Help them to recall the steps in the formation of the teakettle cloud. Lead to the question:

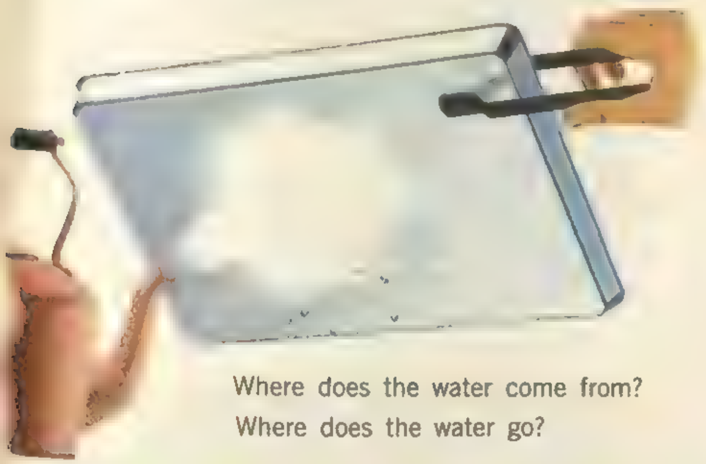
Is the cloud really composed of droplets of water?

Developing the Concept

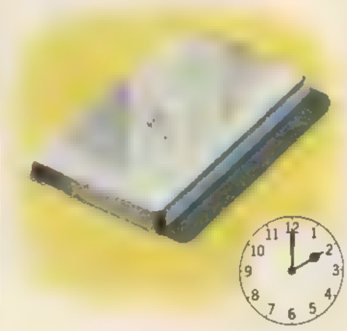
(by emphasis on the subconcept)

1. Invite children to look at the picture at the top of page 41. Call on someone to describe what he sees in it. Ask what this picture has to do with the pictures on page 40. Through discussion, help the class to understand that both pictures show the same teakettle and the same cloud. Ask what is different in the new picture. Encourage the children to mention the new items: the metal sheet (or pan) and the drops of water. Help children to be aware of the function of the items that have been added by asking questions like these:

What do you see on the metal sheet?



Where does the water come from?
Where does the water go?



What do you see dripping off of the sheet?
Is the water in tiny droplets or in large drops?
Where do you think the drops of water are coming from?

Through discussion bring out these understandings:

The water on the sheet came from the cloud.
The tiny ***droplets*** of water in the cloud change to large ***drops*** of water on the sheet.
The large drops run down the sheet and fall.

Discuss how the tiny droplets in the cloud form large drops of water. A *cold* metal sheet is being held in the cloud. The cloud loses some of its heat when it touches the cold metal. As the cloud loses heat, more tiny droplets collect on the sheet, bunch together and become large drops of water.

Now you may ask: **Why don't the large drops of water continue to form a cloud? Why do they run down the pan and fall?**

Help the children to recall what they learned about the pull of gravity as an explanation for the downward movement of the drops.

Let children compare the sizes of "droplets" and "drops," the drops shown on the sheet, and the tiny droplets that form the cloud. They can then reason that a drop weighs more than a droplet, and so the force due to gravity is greater on a drop than on a droplet. A droplet is so light that it seems almost to be floating in the air.

2. Lead the lesson to its final phases by having children study the two pictures at the bottom of page 41. Begin by asking where the water on the sheet came from (bottom left). Then call on someone to read the clock in the picture to establish that the picture shows what the sheet looked like at that time.

3. Next, direct attention to the second picture at the bottom of the page. Ask what time it is now. Have children study the picture carefully to find out what has changed since the first picture was made. **How much time has passed?** Through discussion, bring out the following idea:

In three hours some of the water evaporated from the pan.

4. Now ask the children what they think the pan will look like three hours later. Help them to reason that the water will continue to evaporate; by five o'clock, there will be still less water on the pan.

Explain the changes that are illustrated in the textbook in terms of the following processes: heat changing water to water vapor; and loss of heat changing water vapor to droplets of water, and droplets to drops.

Extending the Concept

Through Investigation. Use a teakettle, water, electric grill, and cookie sheet, to do the investigation shown on pages 40 and 41. Observe the precautions suggested in Lesson 1, *Extending the Lesson.*

Through Key Concept Words. Add *droplet* and *drop* to the Science Vocabulary Chart.

Through Activity. Let the children use sponges, and, if convenient, medicine droppers, to take water from one basin and let it fall a drop at a time into another basin. Let them observe the comparative size of a drop, how it falls, and what happens when it lands.

UNIT FIVE: CLOUDY OR SUNNY

Section 2: Clouds and Rain

CONCEPT
Evaporation and condensation are changes in the state of matter.

LESSON 3, page 42

SUBCONCEPT: Clouds and precipitation result from the cycle of evaporation and condensation.

Aim of the Lesson

To stimulate curiosity as to what clouds are like on the inside; to help children realize the relationship between clouds and rain.

Introducing the Lesson

If weather permits, take the children outdoors and have them look at the sky, or have them look at the sky through the classroom windows. Have them answer such questions as these:

Are there any clouds in the sky? If so, what color are they? Has anyone ever been inside a cloud?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the picture on the upper half of page 42. Call on someone to tell something about the position of the plane — where it is with respect to the earth. Ask what happens when a cloud is in the path (or air lane) in which a plane is flying. Through discussion, bring out the idea that planes fly over, under, and *through* clouds.

If someone in the class has had a recent plane trip, invite him to tell about it. **Did he see any clouds? What did the clouds look like? Did the plane go through any clouds? What did they look like from the inside?** If you have flown through clouds, share your experience with the children.

Develop the idea that while flying through a cloud, one can look out of the window and see what the cloud is like on the inside. The inside of the cloud is made of tiny droplets of water, which are seen as a white mist outside the window.

Through further discussion, lead the class to the following understandings:

Clouds, whether in the sky or near the ground, are made up of tiny water droplets.

Drops of water come from clouds.

To evaluate the lesson, present these problems:

When we look up into the sky, we can see the clouds above us. **Can you think of two ways in which we could look down on clouds and see what they look like on top?** (From mountaintops and airplanes.)

When do we go through a cloud and see what it is like on the inside? (Walk, drive, or fly.)

2. Direct attention to the picture on the lower half of page 42. Through appropriate questioning, establish the fact that the boy is walking in a fog. Introduce the word ***fog***, and invite children to share personal experiences.

Ask how many have ever walked in a fog. Call on volunteers to tell what it is like outside on a foggy day. **What do you see, and what do you *feel* touching your face?**

Again call attention to the boy who is walking in the fog. Ask what will drip from the boy's rain outfit. Through discussion, guide children to the understanding that the drops of water, which will collect on the boy's rain outfit, are formed from the droplets that make up the fog.

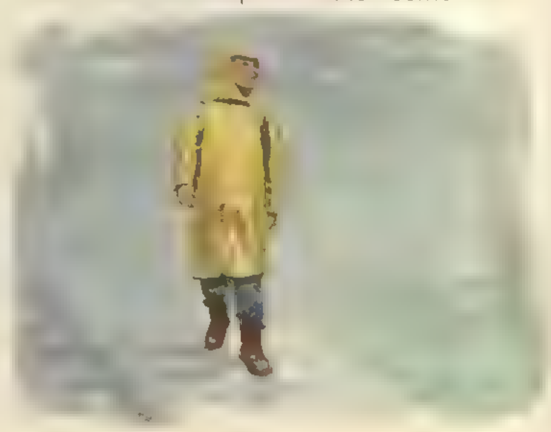
Extending the Concept

Through Key Concept Words. Add *fog* to the Science Vocabulary Chart.

Through Literature. Read "Fog," a short poem by Carl Sandburg, to the class.

Through a Class Project. Make a cardboard window strip by cutting two rectangular holes in a sheet of cardboard. Make cards that will fit the windows and use symbols to indicate SUN, RAIN, SNOW, FOG, WHITE CLOUDS, and GRAY CLOUDS. Each morning, have a pupil place cards in the windows to show today's weather. Discuss the pupil's choice.

Where do the drops of water come from?



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LESSON 4, page 43

SUBCONCEPT: Clouds and precipitation result from the cycle of evaporation and condensation.

Aim of the Lesson

Children observe changes in weather to analyze the relationship between clouds and rain.

Introducing the Lesson

If weather permits, take the class outside to study the sky. Ask whether or not there is likely to be rain today. **Why do we think it will (or will not) rain today?** Encourage children to give reasons for their answers. If it happens to be a rainy day, ask how a rainy-day sky differs from the sky on a clear day. Suggest to the children that they think about this question:

Where does rain come from?

Developing the Concept

(by emphasis on the subconcept)

1. Ask children to look at the picture on the upper part of page 43. Call on volunteers to tell what is happening in the picture. Guide responses to secure answers to the following questions:

What do you see in the sky?

What do you see falling to the ground?

What one word could you use to describe the kind of day shown in the picture?

2. Then help the children to read the question under the picture. Call on those who indicate a desire to answer the question. As soon as someone says that the ***rain*** is coming from the clouds, ask him to tell why he thinks this is so. Through discussion and questioning, try to get the children to recall the teakettle cloud and the clouds on page 42 and to remember that clouds are made of tiny droplets of water. **What happened when the droplets came in contact with the metal sheet?**

Then, as the children look at the rainy-day picture, you may wish to tell them this explanation of rain:

The tiny droplets of water that make up a cloud are very small and light. They are readily moved about by wind. Sometimes the tiny droplets bunch together (scientists don't know yet just why this happens, but it does). Each bunch of droplets becomes a large drop of water. The large drop is too heavy to stay up in the air. **What pulls on the drops of water and makes them fall to the earth? When many drops of water fall from a cloud, what do we say is happening?** It is *raining.* **If no rain comes from a cloud, what does it mean?** It means that the tiny droplets have stayed apart. They have not formed large drops.

3. Direct attention to the picture on the lower part of the page. Ask someone to describe the picture and tell what kind of day it shows. Ask where the clouds are in this picture.

Help children to read the question below the picture. By now children should have no hesitancy in predicting that it will not rain, and they can cite the absence of clouds as the reason for their prediction.

To determine the relative success of the lesson, present the following practical problems for discussion:

Julia and her family went on a picnic. In the morning, there were no clouds in the sky. But on the way home, it began to rain. **How could that happen?** (Rain cannot fall from a clear sky. However, clouds may form and may be moved by wind.)

One morning when it was not raining, David's mother told him to be sure to wear his rubbers and raincoat to school. He did not think he would need them. He changed his mind, though, when he looked up into the sky as he was about to leave. **What did he see?**

Encourage answers that indicate an understanding of the connection between clouds and rain.

Extending the Concept

Through Activity. Give children cotton batting, paste, and sheets of blue and gray construction paper, and help them to make cotton clouds. Cotton may be left in fluffy white bunches for some clouds; pulled into layers or wisps for others; or darkened by rubbing it with gray or black chalk.

Through Key Concept Words. Add *rain* to the Science Vocabulary Chart.

Through Investigation. Make a simple rain gauge, and use it to show that amounts of rainfall vary on successive rainy days. Catch the rain in a coffee can placed in an open area of the playground for say 15 or 30 minutes. Then pour the rain ("the amount that fell into our can during the allotted time") into an olive bottle and measure it with a ruler, or a marked stick. Emphasize the fact that the water in the bottle has just fallen from a cloud. If this is done several times, children will observe that the amount of rainfall for any given time varies.

Where did the rain come from?

Will it rain?

UNIT FIVE: CLOUDY OR SUNNY

Section 3: Water for Clouds

CONCEPT
Evaporation and condensation are changes in the state of matter

LESSON 5, page 44

SUBCONCEPT: The cycle of evaporation and condensation is a result of heat exchange.

Aim of the Lesson

Children seek to explain the function of heat in causing water to evaporate.

Introducing the Lesson

SUGGESTED: a lighted electric lamp

Choose children to approach the lamp and to hold their hands near the lighted bulb but not touching it. Ask them to tell what they feel. Have a child move one hand farther away from the bulb and then nearer to it. Have him tell when the hand feels more heat.

If it is not possible to have a lamp in the classroom, use a picture of one. Lead the class into a discussion to make clear to them that *heat* comes from a lighted bulb and that there is more heat near the bulb than far from it.

Ask what would happen to a wet handkerchief placed near the lamp. **What would happen to a jar of water?**

Developing the Concept

(by emphasis on the subconcept)

Call attention to the three pictures on page 44. Explain that a lamp is being used to do an investigation with water.
1. Choose someone to describe the details in the picture at the top of the page, including what day it is. Establish these facts:

There is exactly the same amount of water in both jars: the tape marks the top of the water.

The lamp is giving heat to one jar.

Explain that the lamp is left on during the investigation.

2. Then call on someone to describe the second picture and tell what has happened by Wednesday. The children will see that there is less water in the jar under the lamp than in the other jar.

3. Now choose someone to describe the picture at the bottom of the page. Ask children to put their fingers on the jar that is nearly empty.

Read the question with the children, and guide their answers toward the following understandings:

Water evaporated from both jars.

More water evaporated from the jar that received more heat.

Heat (from the lamp) hastens evaporation.

If it seems desirable, review evaporation (Lessons 7 and 8, Unit Four). Ask children what is going into the air over *both* jars. Where is more water vapor going into the air, over the jar at the left or the jar at the right? Encourage children to explain their answers in terms of the amount of water that is being changed by heat to water vapor.

Call attention once more to the jar at the right. **Where is the heat coming from to make the water evaporate from that jar?** Encourage speculation: perhaps the room is heated by means of a furnace, or warmed by the sun, or perhaps a little heat from the lamp reaches the second jar. Stress that heat from some source is necessary whenever any evaporation occurs.

Extending the Concept

Through Investigation. Use a lamp and jars of water to do the investigation shown on page 44.

Through Activity. Have the children exhale gently onto their hands to feel that the air they breathe out is warm. Then give them small mirrors or shiny spoons to breathe on, and let them discover that when the warm air touches the cool surface, a small cloud is formed on the surface. The cloud is made up of tiny droplets of water. Help the children to reason from this investigation that their breath contains water vapor, which of course is invisible.

What makes the difference?

LESSON 6, page 45

SUBCONCEPT: The cycle of evaporation and condensation is a result of heat exchange.

Aim of the Lesson

To show that heat *from the Sun* helps water to change to water vapor and go into the air.

Introducing the Lesson

Have the children hold their hands in direct sunlight and feel the heat. Then have them hold their hands in the shade. In this way they can recognize that it is warmer in direct sunlight than in shade.

(If there is no sunshine today, use a picture of a sunny scene in summer and help children to recall the heat from the *Sun* as they walked on sand and sidewalks in summer.)

What happens to water in direct sunlight?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: one measuring cup; two identical glasses or transparent plastic jars; some adhesive tape.

1. Choose someone to explain the legend across the top of page 45. Call on children to name each thing that is shown at the top of the page and is needed for the investigation. You may wish to produce each article as the child names it.

2. Call attention to the picture near the top of the page. Have two children each measure one cupful of water and pour it into the jars. Help them to mark the water level with a strip of adhesive tape.

What will happen to the water?

Why will it happen?

45

3. Then ask the class to look at the left-hand picture at the bottom of the page and tell where jar 1 is to be placed. Let the children choose a sunny spot by a window for this jar.

4. Ask them next to find out from the right-hand picture where jar 2 is to be placed. Find a dark or shaded place in the room for the second jar. Then lead them into a discussion to develop the main points of the investigation.

Jar 1 is left in a place where it will get heat from the Sun.

Jar 2 is left in a place where the Sun will not shine on it.

Both jars are open.

Have someone read the questions on the page.

Encourage children to predict the results of the investigation. If they are hesitant, suggest that they look at page 44 to recall what happened to the water in the two jars shown there. Then return to this investigation and present some questions:

What do you think will have happened by tomorrow?

By the day after tomorrow?

By a week from today?

Why will it happen?

The expected answers may be that some water will evaporate from each jar, that more water will evaporate from the jar in the sunshine (or less from the jar in the shade), and that heat from the sun will make the difference.

However, some alert child may point out that there may not be much sunshine and perhaps the sunshine at this time may not be very hot. Also, the entire room *may* be quite warm, even in the shaded places. A discussion of such possibilities can greatly enrich the lesson. Through the discussion, develop the following general understandings:

More water will evaporate from the hotter jar.

If the entire room is warm, the evaporation from the two jars may be the same.

Since this is *our* investigation, we can wait to find out what happens.

Check for understanding of the role of heat in causing evaporation by discussing a problem such as this:

There were two puddles of the same size on the playground. One puddle was where the Sun shone on it all day. The other puddle was out of the sunlight except for a little while each day. **Which puddle dried up first? What made the difference?**

Extending the Concept

Through Following Up an Investigation. Encourage the children to look at the water in the jars several times each day for a few days. The effect of heat on evaporation may be demonstrated more clearly by covering both jars at night or whenever there is no direct sunlight.

Through Key Concept Words. Add *Sun* to the Science Vocabulary Chart. Explain that the heat from the Sun causes water to evaporate.

With Rapid Learners. Let them insert a thermometer into each jar to find out that the temperature is "this" much higher or no higher in one jar than in the other. Help them to explain how the amount of evaporation is affected by temperature.

LESSON 7, page 46

SUBCONCEPT: Clouds and precipitation result from the cycle of evaporation and condensation.

Aim of the Lesson

To provide an understanding of how evaporation, aided by the sun's heat, supplies water for clouds.

Introducing the Lesson

Display some models and pictures of clouds that have been made by the children. Lead into a discussion of clouds to develop the idea that there may be many clouds in the sky. Recall the amount of rain (and snow) that falls from clouds and that clouds consist of tiny droplets of water. Review the fact that the droplets are formed from water vapor in the air.

How does so much water vapor get into the air?

Developing the Concept

(by emphasis on the subconcept)

Ask children to look at all the pictures on page 46 and to tell the kind of day each shows. They will quickly discover that all four pictures show bright, sunny days.

1. Choose someone to describe the situation in the first picture. Ask whether the day is warm or cold. Since the children are wearing swim suits, we can assume that the day is warm. Direct attention to the swimming pool. **What is happening to the water as the Sun shines on it?** Guide children to the realization that heat from the Sun is changing some of the water to water vapor. Have them point to the place where they think water vapor is going into the air. **Why is it impossible to see the water vapor?**

2. Next, have the children look at the picture of the wet playground and tell what is happening as the Sun shines on it. Ask whether puddles in the shade will also evaporate. **Which puddles will evaporate faster?**

3. Call on someone to describe the third picture. Invite children to tell of their experiences with sprinklers. **What happens to the water we put on lawns?**

Someone may point out that water from a sprinkler soaks into the ground and is used by the roots of the grass (this is the reason for sprinkling). Then ask if all the water from the sprinkler is used in this way. **Why do we have to water the lawn more during hot, sunny weather than during weather that is cloudy and cool?** Through discussion, bring out the fact that the Sun's heat causes water to evaporate rather rapidly from grass and other plants as well as from rocks and pavements.

4. Next, ask a pupil to identify the picture that shows part of an ocean. You may find it necessary to explain that an ocean is a very large body of water, much larger than any pond or lake. Ask what happens when the Sun shines on the ocean. Through discussion, lead the children to the understanding that when the Sun shines on so much water, a great amount of water vapor goes into the air.

Help the children to read the question on the page. Before they answer, have them look again at the pictures. Discuss the answers that they give, and help them to reach these understandings:

Heat from the Sun helps to evaporate water.

There are many wet things and many ponds, lakes and oceans, and so there is much water for evaporation.

When water evaporates, it changes to water vapor and goes into the air.

Clouds form from the water vapor in the air.

To find out how well the children understand the relationship between evaporation and clouds, ask:

Could there be any clouds in the air if water did not evaporate?

Encourage the children to explain their answers in terms of the sun causing large amounts of water vapor to go into the air.

Extending the Concept

Through Investigation. Make a water cycle inside a transparent plastic container. (An oblong two-quart ice cream container works well.) Place the lid upside down on a table, and inside the lid fit some well-watered pieces of grass turf. Move your "miniature greenhouse" to a sunny spot. Heat will cause water inside the container to evaporate. Some of the water vapor will condense to drops of water on the top and sides of the "greenhouse" and may fall as "rain."

With Rapid Learners. Most children know that there is salt in ocean water. Prepare a saturated solution (to represent ocean water) by dissolving as much salt as possible in a half cupful of water. Pour the "water" into a pan, stand it in a warm place, and, later, let the children see what happens to the salt as the water evaporates. (The salt is left behind in the pan.)

Where do clouds get water?

46

UNIT FIVE: CLOUDY OR SUNNY

Section 4: Where Will It Rain?

CONCEPT
Evaporation and condensation are changes in the state of matter.

LESSON 8, page 47

SUBCONCEPT: The weather cycle is related to the water cycle.

Aim of the Lesson

To give children an opportunity to predict the weather based on their understanding of precipitation in relation to the water cycle.

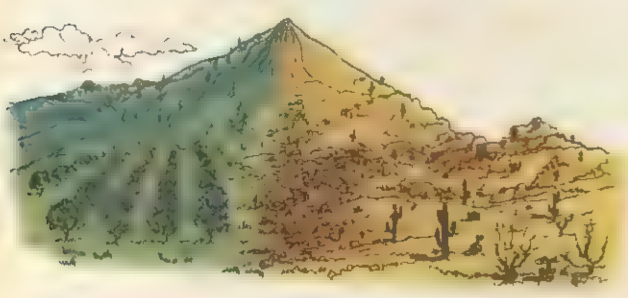
Introducing the Lesson

SUGGESTED: the class weather window and cards.

If the class has been keeping a daily weather window (Lesson 3, page 42) review the weather symbols that have been prepared. Discuss the weather in terms suggested by the cards, as sunny, rainy, foggy, etc. If the class doesn't have a weather window, ask them to pretend that it is summer and they are planning a picnic. They need to know whether or not it is likely to rain today.

What do clouds tell us about rain or sunshine?

Where is it raining?



Which side of the mountain gets more rain?

47

Developing the Concept

(by emphasis on the subconcept)

1. After you call attention to the farm scene at the top of page 47, choose someone to describe what he sees in the sky. Ask what the cloud is made of, and then ask where the water comes from (clouds are droplets that are formed by cooling water vapor that resulted from evaporation).

Call on someone to read the question below the picture. Have the children point to places where the rain is falling. Then present questions such as these:

In the picture, are the farmhouse and barn getting wet? Why not?

Do you think that the horses and cows will get wet? Why do you think so?

Where will the rain drops come from?

Check for understanding of the relationship between the cloud and rain by presenting this problem:

Suppose the wind blows the cloud through the sky until the cloud is right over the farmhouse. **Then if it rains, what would get wet?**

Through their answers, children will reveal understandings such as these:

Rain falls from clouds.

Rain cannot fall from a clear sky.

Wind moves clouds from place to place.

2. Now look at the illustration at the bottom of page 47. Tell the children to study the picture carefully while you read the question below it. Call for volunteers to answer the question. Through discussion of the responses lead the class to these assumptions:

The green side of the mountain gets plenty of rain, and, therefore, many plants grow there.

The other side of the mountain gets little rain, and it looks bare and dry with few green plants.

Introduce the word ***desert*** if the children have not already used it. Invite children to share their knowledge of deserts: places that receive little rain. Use pupils' experiences to develop the following understandings:

A desert is a place where there is very little rain.

Plants and animals that do not need much water live in deserts.

Most plants and most animals live in places where there is plenty of rain.

Extending the Concept

Through Activity. Use a large pickle jar placed on its side, for a desert terrarium. Plant it with small cactus and other miniature desert plants. See *A Sourcebook for Elementary Science*, by Hone, Joseph & Victor, page 82, Harcourt, Brace & World, New York.

Through Key Concept Words. Add *desert* to the Science Vocabulary Chart.

UNIT FIVE: SUNSHINE AND RAIN

Section 5: Summary and Evaluation

CONCEPT SUMMARY
Evaporation and condensation are changes in the state of matter. Changes in the state of matter are determined by a loss or gain of heat (heat exchange).

LESSON 9, page 48

Aim of the Lesson

To give children an opportunity to summarize and evaluate their understanding of changes in the state of matter in relation to clouds and precipitation.

A New View of the Concept

Ask children to look at the pictures on page 48. Each picture represents a problem situation. Explain that they are now going to have a chance to show what they know about clouds, rain, and heat from the Sun by studying the pictures and telling about them.

Fixing the Concept

Tell the children that as they study each picture you are going to ask some questions. They will get the answers from the pictures. Following are some suggestions:

1. Look at the top picture. Remember that water may be solid, liquid, or gas. Now point to and tell about each place in the picture where you think there is water.

Where is there some water in solid form (ice)? What will happen to the ice? Why will it melt? Where is there some water in liquid form?

What will happen to the wet bathing suits? Where, other than the bathing suits, do you think that water vapor is going into the air? Why do you think that water is evaporating?

2. In the second row of pictures, you are to tell us where water vapor is going into the air.

What will happen to the wet chalk board? What makes the chalk board dry? Where does the water go?

What will happen to the aquarium if no one adds water to it? Why is it necessary to keep adding water?

What do you think there is in the flower bowl to keep the flowers fresh? Will some of this water evaporate? Where will the water go when it evaporates?

Look at the two jars of water. **Which jar will have less and less water? Where will the water go? Why will the water not evaporate from the other jar?**

3. In the illustrations at the bottom of the page are some pictures to help you recognize the words. Look at one picture at a time and at the word above it. (In each case ask the children to raise their hands if they wish to tell what they know about the word.)

What do we call water when it is in solid form? In liquid form? In the form of gas?

What are clouds made of? Where do clouds get their water?

How are *fog* and *cloud* alike? Where do we find fog? How is rain different from fog?

Draw the lesson to a close by making children aware of how much they have learned about:

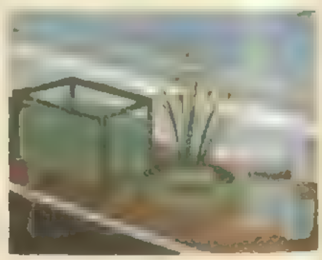
solid, liquid, and gas
water changing from one state to another
clouds in the sky and clouds near the ground (fog)
droplets forming rain drops and falling to earth
heat energy from the sun changing water to water vapor.

Extending the Concept

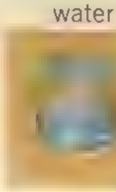
Through Investigation. Let children examine a cactus to see how it can store water for its use. (CAUTION: *Do not touch a cactus.* Even the small, almost invisible spines can cause painful wounds.) Use tongs or thick leather gloves to hold the cactus. Cut off one lobe and slice it open to reveal the moist, juicy interior. Explain that the desert cactus stores water which it obtains during the infrequent rains.

Through Activity. Collect and display pictures of deserts. Explain the presence of flowers in the desert in these terms. Rainfall may occur only once a year. Then, the drab looking plants burst into bloom, as a growth spurt occurs. For a little while, the desert is carpeted with colored flowers.

THE BIG IDEA



water



cloud

fog

48

UNIT SIX: LIGHT AND DARK

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Children are accustomed to the cycle of day and night. "Time to get up!" is heard as day begins, and "Time for bed!" as reluctantly they see day end. They wonder about day and night and why we cannot have day all the time.

They wonder, too, about the way the Sun seems to move across the sky: and they wonder about the Moon, which they sometimes watch from their beds.

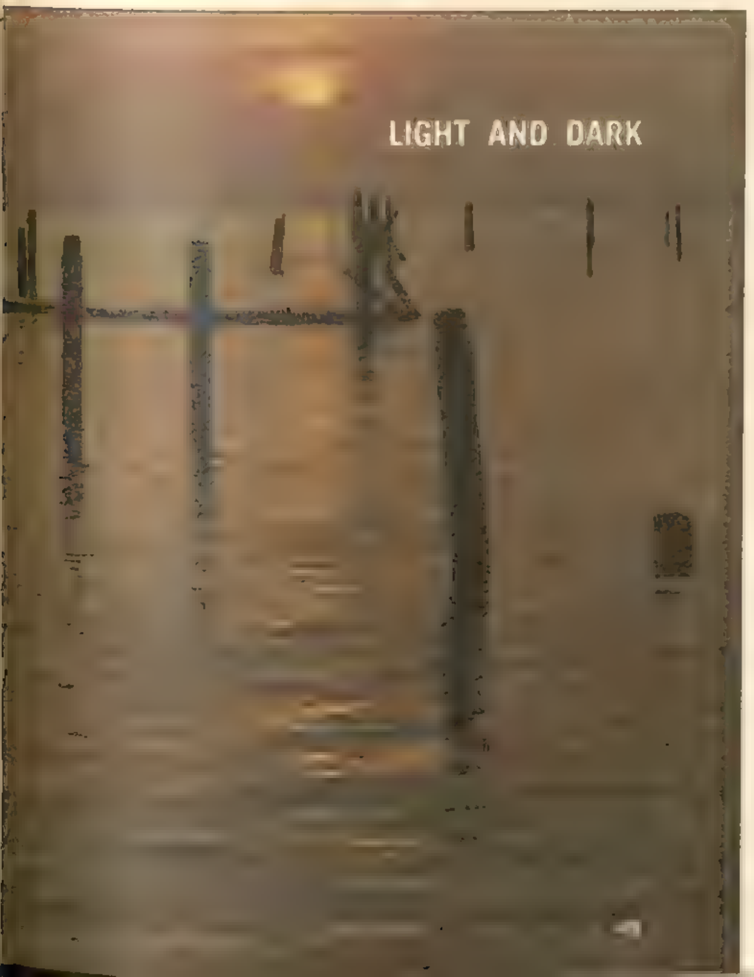
Being children of the "Space Age," they hear about and become interested in astronauts, rockets, spacecraft, and journeys to the Moon. Many of these, which may seem awesome and strange to adults, are taken for granted by children, as part of the world they live in.

They will enjoy investigating the larger world and finding out why some things are as they are.

Content. We live on a moving, changing sphere, in a universe of countless moving, changing bodies.

Our planet is part of the solar system, which includes the Sun, nine planets (including the Earth), satellites of planets, and various other bodies. The solar system is named for the Sun (Latin, *solaris*), which dominates the system in size and weight (mass). The planets revolve around the Sun and the satellites revolve around their respective planets.

In its journey around the Sun, each planet follows its own path, or *orbit*. Each planet requires a different time for one complete revolution. It takes a year for the Earth to make one complete revolution.



Before the sixteenth century, people believed that the Sun, the Moon, and the planets all revolved around the Earth. In that century, the theory of a Sun-centered universe was developed. Today, we know that the Sun is center of our solar system but our solar system is not the whole universe. In fact, it is only an infinitesimally small part of the universe.

In this unit, the development of the conceptual scheme is limited to the subconcept:

The Sun is the source of our light energy.

Sun and Sunlight. Light, like heat, is a form of energy, and its source is the Sun.

The Sun is sometimes spoken of as "our star." It is a star, and is much nearer to the earth than any other star. Like all stars, the Sun is composed of gas substances which send out light.

The Sun shines on the Earth at all times. As the Earth rotates on its axis, half of its surface is always within the light of the Sun and the other half is in darkness.

Rotation causes the cycle of day and night on the Earth. Since the Earth turns from west to east, we see the Sun first in the east (at sunrise) and last in the west (at sunset). It appears that the Sun moves westward across the sky. It is not surprising, then, that for many thousands of years man mistakenly believed this to be the case.

Sun and Shadows. When anything that is not completely transparent comes between the Sun and the Earth, a shadow is cast. Even if an object does not move on the Earth, its shadow shortens and lengthens as the Earth rotates. This is evidence of the change in position of the object relative to the Sun.

Clouds that come between the Sun and Earth cast shadows on the ground. Even on a *day* when the sky is covered with a layer of clouds, we still receive some light from the Sun.

Moon and Moonlight. The Moon is the Earth's natural satellite. It travels in its own orbit, going all the way around the Earth in *about* twenty-eight days.

The Moon, like the Earth, receives light from the Sun. The light we see is sunlight reflected from the Moon.

Shining in the night, the Moon appears to us as the largest and brightest light in the sky. This is because the Moon is so much closer to the Earth than any other natural objects in the sky. As viewed from the Moon, the light on the Earth is also reflected sunlight.

Space and Space Travel. Beyond the thin layer of atmosphere that wraps the Earth and between the countless bodies of the universe, lie vast areas of space. Space is continuously being explored to help us to develop a more complete understanding of the moving, changing universe in which we live. Obviously, the mechanics of space travel are not involved here.

UNIT SIX: LIGHT AND DARK

Section 1: Source of Light for the Earth

CONCEPT
The Sun is the source of our light energy.

LESSON 1, pages 50 and 51

SUBCONCEPT: Day and night result from the rotation of the Earth.

Aim of the Lesson

To help children to become aware of the relationship of day and night; to guide them to the discovery that the sequence of day and night is caused by the Earth's rotation.

Introducing the Lesson

Invite children who have ever watched the Sun rise to tell the class about it. Then ask the same children if they have ever seen the Sun set. If so, let them tell about it. Then ask if the Sun rises and sets in the same place. Have someone tell about where the Sun is at lunch time on clear days. Through appropriate questioning, establish the fact that at different times we see the Sun in different places in the sky.

Why do we see the Sun first in one place and then in another?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a globe of the Earth and a small American flag on a toothpick stuck in a piece of plastic clay; flashlight that throws a beam of light wide enough to cover the globe.

Invite the children to look at the picture on page 50. It is a drawing of the Sun shining on the Earth, which somewhat resembles a ball. Actually, the Sun is so far away from the Earth that they would not both be seen in a real picture of this size.

Call attention to the picture of the Earth. Have someone describe what is shown. (The part toward the Sun is ***light***, and the part away from the Sun is ***dark***.) What persons on the light side may be doing is shown in the top inset (square). Ask whether the children think it is ***day*** or ***night*** on the light side. What persons may be doing on the dark side is shown in the bottom inset. Ask whether the children think it is day or night. Discuss this idea and ask the questions on page 50 to bring out these understandings:

It is day on the Earth where the sunshine is.

It is night on the earth where the Sun does not shine.

Since the Earth resembles a ball, part (half) of it is in daylight while the other part (half) is in darkness.

You know that it is daylight some of the time and dark some of the time. **What do you think happens to make the change from day to night or from night to day?** Let's see if we can find out!

At this point, show the globe to the class and explain that it is a model of the Earth. Choose someone to come forward, and then help him to find the United States on the globe. (You may wish to point out Alaska and Hawaii as the two newest states by putting a piece of clay on each.) Fasten the flag to the globe, approximately at the center of the forty-eight states with the stick pointing toward the center of the Earth. Let children examine the globe and the flag. Through discussion, help them to understand that the flag marks the part of the Earth where our country (the largest part) is located.

Now have the children look at the top picture on page 51. Call on someone to show what is being done in the picture. Give the flashlight to the child and help him to shine the light on the same part of the Earth that is shown in the picture.

While someone holds the flashlight and directs the beam of light, present this problem for discussion:

If this globe were the *real* Earth, with light shining on it, would the light be coming from a flashlight? What would the light be coming from?

Guide children's thinking and help them to realize that the real Earth gets light, not from a flashlight, but from the Sun. Suggest that, since we call the globe *Earth*, we can call the flashlight *Sun*. Of course, we know that the Sun is not a big flashlight. However, it does send out light. So, we shall pretend that the flashlight represents the Sun which is sending its light to the Earth.

Call on children to take turns holding the flashlight and shining the light as nearly as they can on the part of the Earth shown lighted in the picture. While this is being done, help someone to read the first statement below the picture: "Night comes after day." Ask: **Why is it day?** The light (Sun) is shining on part of our country.

Call on another child to read the second statement: "Day comes after night." Direct attention once more to the picture and the model, and help the children see that part of the globe is dark. The Sun is not shining on that part. It is night on that part.

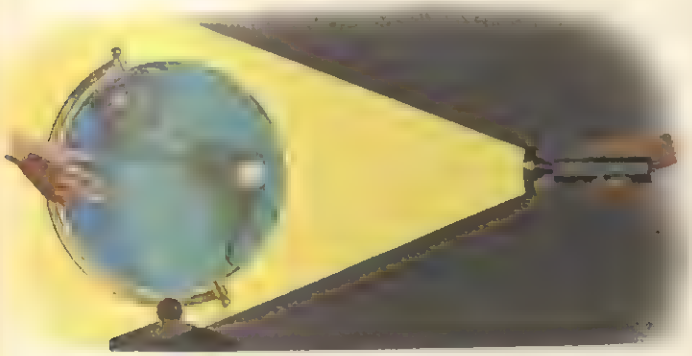
You may find that here is a good stopping place for this lesson. Then you may wish to begin the next science session with a quick review of the picture at the top of page 51 before introducing the concept of the earth turning.

Tell the children to look at the bottom picture on page 51. It represents the Earth later on the same day as the upper picture. Explain that the flashlight (the Sun) is in the same position as it was in the upper picture. It has not been moved. **Is the same part of the Earth in darkness as before? Is the same part in light?**

Read the question below the picture. From the details in the picture, and from previous experiences with day and night, some children may be ready to volunteer the information: "The Earth turns."

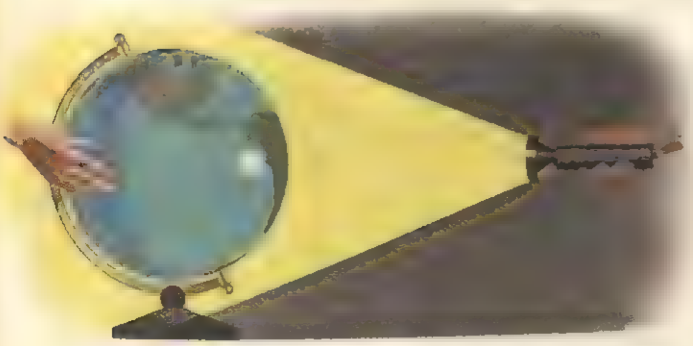
To emphasize the "turning," have a child hold the flashlight as before, and turn the globe from west to east until the western hemisphere is all in the lighted part. Continue to turn the globe slowly until the Earth has made a complete rotation.

Call on some children to take turns holding the "Sun," and on others to turn the globe. Introduce the word ***rotates*** and explain that the Earth rotates; it turns around and around.



Night comes after day.

Day comes after night.



What does the Earth do?

51

Through discussion (and further demonstration if necessary) lead children to the following understandings:

As the Earth rotates, half of the Earth is always in the light and the other half is in the dark.

It is day on the half that is in the light; it is night on the other half.

Day changes to night, and night changes to day over and over again because the Earth rotates.

Check for comprehension by asking what it would be like if the Earth did not rotate. Children will reason that there would be no change from day to night if the Earth did not rotate; it would always be day on the side of the Earth on which the Sun shone, and always night on the other side.

Extending the Concept

Through Activity. During free time, encourage children to explore the globe, noticing water and land, and looking at all parts of the Earth.

Help children to locate their community on the globe. Make a small cutout of your school, and tape it to the proper location. Attach the small flag beside it. Then, let a child hold the flashlight "Sun" while you rotate the globe (from west to east) showing the change at your school from day to night, and from night to day.

Through Key Concept Words. Add *day, night, light, dark,* and *rotates* to the Vocabulary Chart.

Through Art. Give the children some sheets of black paper and pieces of white and yellow chalk. Let them make pictures of the sky at night. (Through the details they show, you will discover how much awareness they have of Moon and stars.)

With Rapid Learners. Have children practice with the flashlight and the globe to show when it is about sunrise and when it is about sunset in your community. Ask them to determine why the rotation of the Earth makes the Sun appear to move across the sky.

LESSON 2, page 52

SUBCONCEPT: Day and night result from the rotation of the Earth.

Aim of the Lesson

To give children some general information about an astronaut leaving the Earth and journeying into space.

Introducing the Lesson

REQUIRED: information (and pictures on a bulletin board if possible) about astronauts, rockets, space capsules, and *recent* space exploits.

Initiate a sharing period during which the children tell what they know about space travel. Before going on with the lesson, pose the question:

Can an astronaut see the Earth as he goes over it in space?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a globe of the Earth.

1. As children study the first picture on page 52 (top left), ask whether they know what a space traveler is called. If no one uses the word ***astronaut***, introduce it and explain that an astronaut is a specially trained pilot who travels through space (*astro* refers to stars).

Refer to the globe, and ask for a volunteer to show where an astronaut travels. Use the term ***space***, and help children to understand that as an astronaut leaves the Earth he passes through the Earth's layer of air (or atmosphere) and enters space, where there is practically no air.

Encourage a discussion of space, and through it lead the class to visualize the Earth as a solid ball, surrounded by a thin layer of air and a vast area of outer space.

2. Once the children have an accurate concept of *astronaut* and *space*, direct their attention to the second picture on page 52 (top right). Use questions to review the need for energy to move a rocket up, away from the Earth. Have the children point to the part of the picture that is in color, and help them to identify it as that part of the rocket in which the astronaut rides.

Next, present the question of the time of day shown in the picture. **Is the rocket ready to blast off at night or in the daytime? How can we tell?**

3. Now guide attention to the picture across the bottom of the page and call on children to describe it in detail. Ask which part of the rocket it shows. Explain that after the rocket (seen in picture above, right) is well away from the Earth, the part containing the astronaut separates from the rocket and continues its flight alone.

Ask whether the astronaut can see out of the part in which he rides. At this time, you may wish to introduce the term ***capsule*** (and to encourage its use) to identify the part of the rocket in which the astronaut rides.

Call attention to the window in the space capsule. Children will reason that the astronaut can see through the window.

If there are children in the class who have recently traveled by plane, invite them to tell what they saw when they looked out of the windows (clouds, other planes, ground.)

Encourage children to make suggestions as to what an astronaut sees as he travels in space around the Earth. Through informal discussion and sharing of information, help children reach these assumptions:

An astronaut travels in space, high above (away from) the Earth.

He can look out of his window and see the Earth as he travels around it in space.

Conclude the lesson by telling the class that in the next science lesson they will find out more about astronauts and what they see.

Extending the Concept

Through Activity. Encourage children to bring in pictures of astronauts; rockets on launching pads, blasting off, and in flight; and toy models of spacecraft. Use them for an exhibit on space travel.

Through Key Concept Words. Add *space* and *astronaut* to the Science Vocabulary Chart. Add *capsule* if the word has been introduced and used in class discussion.

Through Library Research. On the library table, provide factual picture books showing astronauts and space travel. (NOTE: It is probably desirable to avoid books that show space fantasies. These may provide misconceptions in children's minds.)

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LESSON 3, page 53

SUBCONCEPT: Day and night result from the rotation of the Earth.

Aim of the Lesson

Children begin to realize that when an astronaut orbits the Earth in space, he passes over the day side and the night side of the Earth.

Introducing the Lesson

REQUIRED: a display of pictures of astronauts and space flights.

Provide time for the children to look at the space display and discuss it informally among themselves. Then, through a class discussion, review the assumptions at the end of Lesson 2, page 52. Stimulate children's curiosity about the path along which an astronaut moves after he has left the surface of the Earth. Encourage them to identify with an astronaut on a solitary flight in outer space and to try to imagine how he feels and what he sees.

What does the Earth look like to an astronaut journeying through space?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: the world globe with the United States marked with a flag, a small model rocket or space capsule, and a flashlight.

1. Call on volunteers to interpret the problem situation in the picture at the top of page 53. The children will recognize it as a view of the Earth and a space capsule. Choose several children to come forward and take turns using the globe and the model spacecraft to show how the capsule in the picture is going around the Earth. Help the class to understand that the capsule travels in space all the way around the Earth.

NOTE: Avoid using the word *circle* but do not attempt, at this time, to explain that the path is an *ellipse*.

Review the concepts of day and night that were developed in Lesson 1. Help the children to recall that it is day where there is sunlight on the Earth; that half of the Earth is having day, while the other half is having night; and that day changes to night as the Earth rotates.

2. Now direct attention to the picture at the bottom on the left. Remind the class again that the astronaut is in space traveling around the Earth. Call on someone to tell what this picture shows. Ask what the astronaut sees now when he looks down on the Earth. Then choose someone to read the question below the picture: **Where is it light? Why?**

Through discussion, help children to reach this understanding: It is light because the astronaut is now going over the *day* part of the Earth.

3. Call on someone to tell about the picture at the bottom on the right. Ask what the astronaut sees now when he looks down on the Earth. Then choose someone to read the question: **Where is it dark? Why?**

Through further discussion, guide the class to this understanding:

It is dark because the astronaut is now going over the *night* part of the Earth.

Conclude the lesson by choosing children to use the flashlight, the globe (in a darkened place), and model rocket, and show how an astronaut goes over the day part and the night part of the Earth.

To evaluate the success of the lesson, present the following problems.

If an astronaut goes *once* all the way around the Earth, how many times does he go over the day part? How many times over the night part?

Encourage answers that reveal an understanding that a space flight all the way around the Earth must go over both the day half and the night half.

Extending the Concept

Through Art. Encourage children to make pictures showing rockets, astronauts, and space trips.

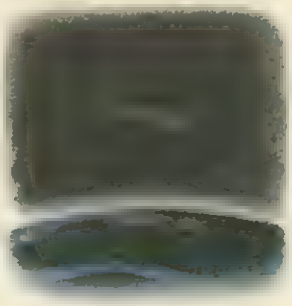
Through Language. During a language lesson, have the children dictate space stories. Have the school office provide typed copies so that the children can make the stories into space booklets with illustrations.

If it is possible to use a tape recorder, have the children tell their stories and then listen to the playback — perhaps at a later date.

With Rapid Learners. Explain that a plane goes up but remains in the air (the atmosphere); a rocket goes up but travels in space. Ask children to find out the difference between *air* and *space*.

Where is it light? Why?

Where is it dark? Why?



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UNIT SIX: LIGHT AND DARK

Section 2: Shadows

CONCEPT
The Sun is the source of our light energy.

LESSON 4, pages 54 and 55

SUBCONCEPT: An opaque object blocks the Sun's light and casts a shadow.

Aim of the Lesson

To provide experiences by which children discover that a shadow is caused by an obstacle in the path of light: that a cloud is an obstacle that casts a shadow on the Earth.

Introducing the Lesson

Take the class out on the playground for a "shadow hunt." Encourage the children to look at their own shadows while standing still and while moving and at the shadows made by trees, fences, and buildings. Use the word ***shadow*** to describe what they see. If the weather makes this activity impractical, use a lamp or flashlight in the classroom to make shadows of some of the children. Encourage the class to wonder about shadows by asking:

What makes a shadow?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: large pieces of heavy cardboard like the ones shown on page 54; a flashlight or gooseneck lamp if there is no sunshine in the room.

1. Direct attention to the picture on the pupil's page. The children will see a shadow made by holding a piece of cardboard in the path of the sunlight. Ask the class to look at the shadow, and to think about (but not tell) why shadows are made.

Hold up a rectangular piece of cardboard and ask who would like to use it to make a shadow. Choose a volunteer. Encourage other members of the class to make suggestions, guiding the child with the cardboard and helping him to find the place where the cardboard will cast a shadow. The need for sunlight will become apparent. (NOTE: At this stage, it is probably advisable to hold the cardboards so that the shadows appear in the general shape of the originals. Changing the shape of shadows can wait for a later grade.)

If there is no Sun shining into the classroom, use a lamp or flashlight and pretend that the light is coming from the Sun, as in Lesson 1, page 51.

Using cardboard (and other objects), give many children opportunity to explore the making of shadows.

Then call attention once more to the textbook and ask the children to study the picture on page 54. As they are doing this, read (or have a child read) the questions.

The answer to the first question is quite obvious. The light in the picture is coming from the Sun. The answer to the second question, however, may not be apparent immediately. To help children understand why there are shadows, ask guiding questions, such as these:

Where is the sunlight coming from?

What sort of thing does the sunlight shine through?

What sort of thing does the sunlight not shine through?

What happens when something that the Sun does not shine through gets in the path of the sunlight?

Why is there a spot of sunlight within the shadow of the cardboard?

Can you see shadows when the Sun is not shining?

Through discussion (and further demonstration if necessary) children may form the following assumptions:

Our light comes from the Sun.

A shadow is made by something that gets in the path of the sunlight and does not let the light through — something that comes between the Sun and what it was previously shining on.

2. Now direct attention to the picture at the top of page 55. Call on someone to find the shadows in the picture. Ask what is making the shadows that are seen on the ground. Encourage children to apply what they have learned about shadows. Help them to understand that the clouds, which

Where does our light come from?

Why do we have shadows?

are in the path of the Sun's light (between the Sun and the Earth), are causing the shadows.

3. Next, have the children study the picture at the bottom of the page. Ask someone to tell why there is no shadow of the girl in this picture.

Choose someone to read and answer the question, **Where is the Sun?**

Through discussion, help children to realize that in the bottom picture, clouds cover the part of the sky that is shown. These clouds are in the path of the sunlight. The clouds do not let the sunlight through. Instead, they make a big shadow that extends over that part of the Earth shown in the picture.

Encourage children to describe a day that looks like the one in either picture on page 55. Ask them to use words such as clouds, shadows, sunlight, etc., to show their understanding of the relationship between shadows and clouds. Examples: "a shadowy day," "a day with clouds in the way of sunlight," "a cloud-shadow day."

To evaluate the success of the lesson, ask the following question:

What has to happen in the bottom picture before the girl can see the Sun and her own shadow?

Through their answers, children will reveal their understanding that when clouds *move* their shadows move across the Earth. Also, if a child stands on a shadow of a cloud, the sunlight does not reach him and he has no shadow.

Extending the Concept

Through Activity. Make a shadow portrait for an Open House or other school exhibit. Use a slide projector or other source of strong light to cast each child's shadow on a sheet of paper (black, if available) fastened to the wall. While one child is being silhouetted, let a second child use colored chalk or crayon to outline the shadow. Then, let children cut out their own shadow pictures for use in a class shadow frieze on a background that contrasts with the silhouettes.

Through Key Concept Words. Add *shadow* to the Science Vocabulary Chart.

Through Investigation. Let children try to make shadows in sunlight (or in light from another source) with various transparent, translucent, and opaque materials. Use cellophane, glass, water in a glass, pieces of wood and metal, etc. The children will discover that light goes through some materials and no shadows are cast. They will discover also that a little light goes through certain materials and only faint shadows are cast. And, finally, that no light goes through some materials.

Where is the Sun?

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LESSON 5, page 56

SUBCONCEPT: The position and length of shadows are determined by the position of the light source in relation to the object.

Aim of the Lesson

To help children become aware of the changes in the lengths and changes in the positions of shadows as the earth rotates during our daylight.

Introducing the Lesson

REQUIRED: a copy of the poem, "My Shadow" by Robert Louis Stevenson.

Read aloud the poem and discuss it with the children. Ask why the little boy thought his shadow had stayed in bed. Invite the children to tell of experiences with their shadows while playing or while walking to and from school. Ask whether their shadows change in size, as the child's shadow does in the poem. Lead children to wonder:

Why is my shadow sometimes tall and sometimes small?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the three trees shown in the top picture on page 56. Call on children to point to each shadow. Ask for a volunteer to explain where the light is coming from.

The trees are in the path of the Sun's light. Ask the class whether they can see through a tree as they can through a window. Similarly, sunlight goes through a window, but it does not go through a tree. Have a pupil tell what happens when an object is in the path of the Sun's light but does not let the sunlight through. He should be able to state that each tree casts a shadow. The shadow is on the side of the tree away from the Sun.

Next, help someone to read the words *early morning* below the picture. Explain that early in the morning we see the Sun low in the sky because the Earth is rotating toward the Sun. The whole height of the tree is in the path of the sunlight. At this time, shadows are long.

2. Then move to the middle picture, and ask how the shadows have changed. **Are they long? Are they on only one side of the trees?** Call on a volunteer to tell where the Sun must be when the trees have these small, rounded shadows. The Sun is now directly above the trees.

Then call attention to the word *noon*, and explain that at noon ("at lunch time" or "in the middle of the day"), we see the Sun high in the sky because the Earth has rotated through half of our daylight time.

3. Next, direct attention to the picture at the bottom of the page, and ask children what time of day it is now. Help them to read *early evening* and to understand evening as a time near the end of daylight. Ask where they see the Sun in the sky in the early evening. **Are the shadows long or short? What has the Earth been doing between the time shown in the middle picture and that shown in the bottom picture?**

Have the children compare the shadows in the morning scene with those in the evening scene. **How do the shadows differ?** Then ask how morning and evening shadows differ from shadows at noon.

Through discussion, develop the following understandings:

In the morning and in the evening, we see the Sun low in the sky. Then each tree makes a long shadow. In each case the shadow is on the side away from the Sun.

At noon we see the Sun right over the trees. Then each tree makes a small shadow.

As the Earth rotates, the Sun appears to be in different positions in the sky.

Shadows change in position and size as the Earth rotates.

Now ask children to answer the question that appears at the end of the introduction.

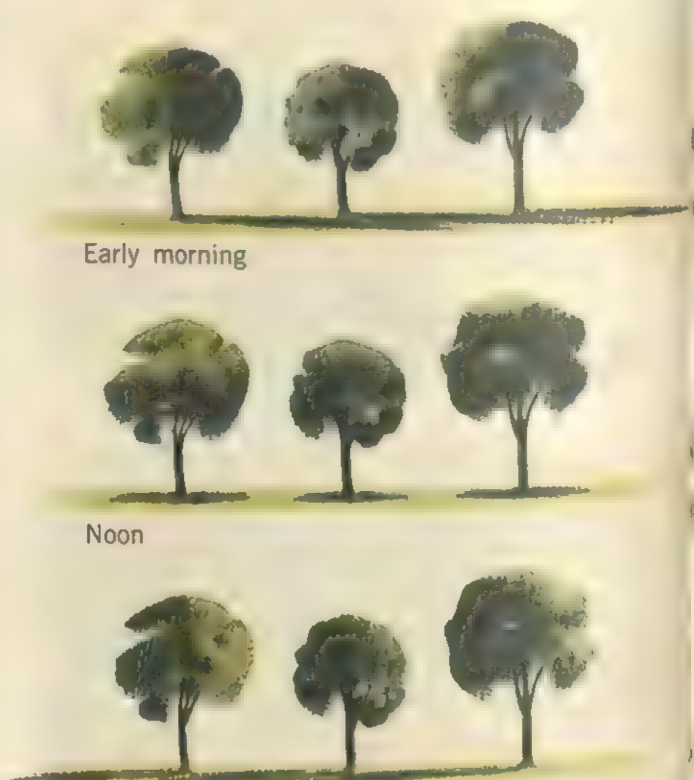
Extending the Concept

Through Investigation. Use a flashlight that throws a wide beam to demonstrate changing shadows. Using a child to cast a shadow, hold the light low on one side, directly overhead and then low on the other side.

Through Activity. Make a "shadow stick" by putting a yardstick, broom handle, or dowel rod into the ground where there is sunlight all day. Have the class look at the shadow every hour to see how the shadow changes.

Through a Field Trip. Visit a park or garden to see a sundial on a sunny day. Help children to understand how a shadow shows the hour.

Through Art. Suggest that children make pictures of people, houses, trees, etc., showing Sun and shadows. Help them to recall that a shadow is on the side away from the Sun.



Early morning

Noon

Early evening

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UNIT SIX: LIGHT AND DARK

Section 3: Source of Light for the Moon

CONCEPT
The Sun is the source of our light energy.

LESSON 6, page 57

SUBCONCEPT: The Moon shines by reflected sunlight.

Aim of the Lesson

To help children become aware that the Moon, like the Earth, gets its light from the Sun.

Introducing the Lesson

SUGGESTED: a bulletin board display of pictures showing the sky at night, a globe of the earth, an orange, and a wide-beam flashlight. Use the globe, orange, and flashlight to make models of Earth, Moon, and Sun, as on page 57.

Call on children to explain the "model." Discuss the difference between a model and the real thing. Encourage them to compare the night sky with the sky in the daytime. As children mention the ***Moon,*** lead to these questions:

Is the Moon a nighttime Sun?
Is it like the Sun, except that it shines at night?

Where does the Moon get its light?

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Developing the Concept

(by emphasis on the subconcept)

1. Invite the class to look at the picture at the top of page 57. Call on someone to explain why the picture shows nighttime. Call on someone else to tell where the Sun is shining in relation to the children in the picture.

Challenge the class by presenting this problem:

Since the Sun is not shining on the part of the Earth shown in the picture, why is there *some* light on the children? Why isn't everything completely dark?

Suggest to the class that they think about their answers while they continue to study the picture of the Moon. Ask: **When have you seen the Moon look as it does in the picture? Are the Moon and the Sun alike, or different? In what ways do they seem to be different?**

Encourage children to share any information about their impression of the Sun and the Moon. Help them to reason about the differences between the Sun and the Moon:

The Sun shines by day, the Moon by night.

In sunlight, things are clear and easily seen. In moonlight, things are much less easily seen than in sunlight.

The Sun is so bright that we should never look directly at it; it is safe to look directly at the Moon.

2. Now have the class study the picture at the bottom of the page to see an important difference.

Begin by reading the question: **Where does the Moon get its light?** Explain that the children in the picture are making a model to show the Sun (flashlight), the Earth (globe), and the Moon (orange). They are making the model to help them to discover the answer to the question.

Give the class plenty of time to study the picture. You may find it necessary to guide their thinking by asking:

Does the Sun have light of its own?

Does the Earth have light of its own? Where does the Earth's light come from?

Does the Moon have light of its own? Where does the Moon's light come from?

Could we have moonlight if the Sun did not shine? Why not?

Through further discussion and by repeated reference to the models shown in the picture, lead the pupils to these understandings:

Only the Sun has light of its own.

The Moon (like the Earth) gets its light from the Sun.

Extending the Concept

Through Key Concept Words. Add *Moon* to the Science Vocabulary Chart.

LESSON 7, pages 58 and 59

SUBCONCEPT: The Moon shines by reflected sunlight.

Aim of the Lesson

To give children an opportunity to discover how light from the Sun is reflected from the Moon to the Earth.

Introducing the Lesson

Lead children into a discussion of the Moon and moonlight. Encourage them to describe moonlight as they have seen it, perhaps streaming through their windows at night. Through the discussion, review the source of the Moon's light. Bring up the question:

How does sunlight, shining on the Moon, reach us on the Earth?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a globe, a sheet of white paper, a mirror, and a flashlight.

Call on someone to explain the reason for the colored strip on page 58. Review the meaning of the word, *Investigation*. Choose children to tell what things are needed for this investigation.

1. Then help the class to read the question on the page. The investigation suggested in the picture is an attempt to find the answer to this question. Through class discussion, develop the idea that a light (the Sun) is shining on a sheet of paper (the Moon) and that some of this light reaches the globe (the Earth).

Place the globe on a table away from direct sunlight. Choose two children to do what is shown in the picture. Have one child shine the light onto the paper, which is held by a second child. Encourage the class to tell the second child which way to move the paper so that light reflects onto the globe.

Let other children take turns holding the flashlight and the paper. Allow plenty of time for each demonstration of light being reflected from the paper onto the globe.

If direct sunlight is available, call on several children to take turns using a mirror to reflect light from the Sun onto various surfaces: walls, ceiling, and the globe.

Then have someone hold the mirror in a darkened part of the room. Ask children whether the mirror has any light of its own and where the light came from that the mirror sent to the walls, ceiling, and globe.

Through discussion of the children's answers, lead them to the following assumptions:

Neither the mirror nor the paper has any light of its own.

Both send out light that they get from something else.

The paper sends out light from a flashlight, and the mirror sends out light from the Sun.

Ask the children whether the mirror and the paper are more like the Sun or the Moon. Help them to answer in terms of which sends out its own light and which sends out light it gets from something else. Guide them to the decision that the paper and the mirror send out light much the way the Moon does. Of course, the surface of the Moon is not flat like that of the paper nor polished like the mirror.

Introduce the word ***reflect***, and explain that the Moon reflects light. It reflects, or sends out, light that comes from the Sun.

Now return to the question at the bottom of page 58. Encourage children to use *reflect* in their answer.

2. Next, have the class study the picture on page 59. Explain that this picture shows how the Moon and the Earth get light from the Sun. The Sun is far, far away from both the Moon and the Earth. The Sun's light travels through space and shines on half of the Earth. It also shines on half of the Moon.

Have children point to the part of the Earth that is lighted by the Sun — the day side. Have them point to the night side.

Next have them point to the part of the Moon that is lighted by the Sun. To help them understand why we see the light on the Moon at night, present the following questions:

Is the Moon in this picture on the day side or the night side of the Earth?

Which side of the Moon is light, the side toward the Sun or the side away from the Sun?

Which side of the Moon is light, the side toward the Earth or the side away from the Earth?

How does the Moon send light to the Earth at night?

In the discussion of the questions above, some alert children may point out that the Moon does not always look as it does in the picture. Also, on some clear nights we do not see the Moon at all.

If such problems are brought up, explain that we are not quite ready to make a careful study of this idea, but the chil-

Why does the Moon shine?

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dren may think about it as follows: The Moon travels all the way around the Earth, with the same side of the Moon always facing the Earth. When the sunlight is on the side of the Moon away from the earth, we do not see the Moon at night. When the sunlight is on the side toward the Earth, we see a full (or round) Moon. In between the times of no Moon and full Moon, we see different parts. (Show cutouts of a crescent, quarter Moon, half Moon, and three-quarter Moon to illustrate your explanation.) However, the important point in today's lesson is that the Moon reflects sunlight to the Earth.

Evaluate the children's comprehension of such reflection by presenting problems such as these:

The Moon sometimes is called "a mirror in the sky." **Can you think of a reason why?**

Study the problem situation on page 59. Imagine that the Moon has moved around to the day side of the Earth. If you were then on the Moon and could see the Earth, you would see the lighted side of the Earth. What sort of light would you see? ("Earthlight" — sunlight reflected from Earth to the Moon.)

Extending the Concept

Through Key Concept Words. Add *reflect* to the Science Vocabulary Chart.

Through Library Research. Have available some science picture books and story books about the Moon. Encourage children to use the books to find out what the Moon is like.

With Slow Learners. Supply the children with various shiny materials, and let them practice reflecting light from the Sun (or from some other source) onto the wall.

The Sun lights the Earth and the Moon.

With Rapid Learners. Tell the children that it takes the Moon about a month (twenty-eight days), to travel all the way around the earth. Introduce the word **month,** relate it to the number of days shown on a calendar. Have someone explain how the word *month* came from *Moon.*

UNIT SIX: LIGHT AND DARK

Section 4: Summary and Evaluation

CONCEPT SUMMARY
The Sun is the source of our light energy. Day and night result from the Earth's rotation. The Moon shines by reflected sunlight.

LESSON 8, page 60

Aim of the Lesson

To give children an opportunity to apply to new situations their understanding of the Sun as the Earth's source of light.

A New View of the Concept

REQUIRED: a flashlight and a mirror.

Ask the children to catch the light with the mirror. Ask them to imagine that the flashlight is the Sun and that the mirror is the Moon.

How could they block the light and thus make a shadow? In what way does the mirror resemble the Moon?

Developing the Concept

(by emphasis on the subconcept)

As children open their textbooks to page 60, read the title, with which they should now be familiar.

As children study the pictures, you may wish to use comments and questions such as the ones suggested:

1. Look at the picture at the top of the page. **What time of day is it? Do you think it is morning, noon, or evening? Why?** Tell where the shadows would be if it were noon. **Would they be long?** Tell where the Sun and the shadows would be if it were morning. **Would the shadows be small or long?**

2. Now look at the picture in the center row. Point to the Sun in the picture. **What time of day is it?** Point to the sailboat. Something is missing from the picture. **What is missing? If it were evening, where would the shadows be in the picture?**

3. Look at the bottom picture. Point to the shadows. Show where the Sun should be (in what direction). **If the Sun were over here (on the right), where should the shadows be? If the Sun were over here (on the left)?**

4. After the children have answered the questions and discussed the statements have them look again at the pictures. Ask them to tell once more which picture shows noon, which shows morning, and which shows evening.

Conclude the lesson and the unit by having children respond to questions such as the following:

Could there be any shadows if the Earth were always dark? Why not?

Where does the Earth's light come from? The Moon's light?

What does the Earth do that gives us a change from day to night?

Extending the Concept

Through Investigation. In discussing the night sky, children may say "the *little* star" or "the *big* Moon." Explain that the moon is much, much smaller than a star. To help them to understand that the moon seems larger to us because it is so near, have them do the following investigation. Make a ring with thumb and one finger. Look through the ring at a marble, held quite near, and them at a basketball, held at the other end of the room or across the play yard. They will discover that the small marble can appear to be larger than the basketball.

Through Art. Invite children to make pictures showing the Earth, Sun, and Moon (and astronauts in capsules, too, if they wish). Encourage them to feel and express the relationships in the universe.

Through Review of Key Concept Words. Review words that were entered on the Science Vocabulary Chart in Unit Six.

Conduct a review of the new technical words in this unit. If there are children who are able to read any of the words, let them do so. However, in vocabulary reviews, understanding rather than word recognition is important. For example, one way to review *reflects* is to say, **"What do we mean by reflects?"** Then call on children to tell something about the word or to use it in a meaningful way in a sentence of their own. Ask for volunteers to demonstrate in pantomime the meaning of each word reviewed.

UNIT SEVEN: PLANTS AND MORE PLANTS

CONCEPTUAL SCHEME
Living things are products of their heredity and environment.

Children are curious about leaves, flowers, seed pods, and seeds. They like to make gardens and to watch plants growing in pots or boxes on a windowsill. Plants are living things that children can care for, enjoy, and understand. As plants grow, children can watch the changes that take place.

In Unit Seven, children will have many experiences with growing plants. They will develop good habits of observation and desirable techniques for setting up their own investigations. Through their experiences in this unit, they will first discover some of the basic patterns found among all living things; and then they will increase and deepen their awareness of these patterns.

Content. A bean seed can grow into a new bean plant that will look like the original plant, and a robin's egg can hatch into a baby robin that will eventually become a full-grown robin.

The surroundings (the environment — food, temperature, moisture, light, etc.) in which a young plant or animal finds itself have much to do with its growth. If the environment satisfies the needs only partially, the plant or animal may survive but be poorly developed. If the environment is definitely unsatisfactory, the plant or animal dies. The environment, however, cannot cause one kind of living thing to change to another kind.

In Unit Seven the concept within the conceptual scheme is that organisms (living things) reproduce their own kind.

New Plants from Seeds. The green plants with which we are most familiar bear seeds. Each seed contains the beginnings of a new plant and at least some food for the plant's use during the early stages of its growth. For example, when a lima bean is split open, the beginnings of a new plant and a store of food for use in its early growth are revealed.

On the outside of every seed is a sort of skinlike covering called the *seed coat.* This coat is split open when the seed soaks up water and swells, and the new plant begins to grow. The root, usually the first part of the new plant to push its way out of its seed, grows downward. Following the appearance of the root part, the beginning of the shoot, or stem can be seen pushing upward. Soon the first leaf or pair of leaves grow out from the stem.

The Formation of Seeds. At a certain age, seed-bearing plants have flowers of some sort. Flowers contain a plant's seed-making parts. The purpose of the flower is to form seeds.

With many kinds of plants, all the parts necessary for forming seeds are contained in each flower. With some plants, however, a part of one flower (pollen) must be carried to another flower in order for seeds to form. Transferring pollen is the work of insects, birds, wind, water, or gravity (or plant growers).

As seeds begin to ripen, the seed-containing part of a plant becomes larger and larger and develops into a fruit. Nuts, cucumbers, string beans, milkweed pods, cockleburs, oranges, apples, and peaches are all fruits of plants.

The chief purpose of the fruit is to contain the seeds as they grow. In many instances, however, the fruit also helps to distribute the seeds when they are ripe and ready to develop into new plants. All seeds, however, do not become new plants. Many are used as food, many do not grow, and many are killed by dry, wet, or cold weather.

New Plants from Parts of Plants. Some plants are able to develop into whole new plants from pieces of stem, roots, or leaves. A plant grown from part of another is always like the plant from which the part was taken.

Food and Green Plants. All green plants are able to make their own food. They do this by using energy from sunlight and materials obtained from water and air. Neither man nor any kind of animal is able to make food.

Without light, water, and air a green plant cannot survive. Without plants, no other life could survive.

Mold, a Nongreen Plant. The mold that covers a piece of neglected food is actually a mass of tiny plants. Mold plants do not make their own food. They do not have flowers and seeds. Instead, new plants come from spores, which are so tiny that you cannot see them. Mold spores float nearly everywhere in the air about us. When they land on something that supplies the proper food and growing conditions, they grow into new plants.

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 1: Ripe Seeds from a Plant

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 1, page 62

SUBCONCEPT: Plants can reproduce their own kind through seeds.

Aim of the Lesson

Children discover through experience that a single plant produces many seeds.

Introducing the Lesson

REQUIRED: dried lima beans (lima bean ***seeds***), at least one for each child.

Pass out the seeds and give children time to examine them. The children may recognize them as lima beans, but may not know that they are seeds. Pose the question:
From what do we get lima beans?

Developing the Concept

(by emphasis on the subconcept)

1. Invite the class to look at the pictures on page 62. Call on someone to tell what he sees in the first picture. Identify the ***plant*** as a lima bean plant, and call attention to the leaves, and the green pods.

2. Choose another child to interpret the second picture. Ask the class to study the picture to find out what is inside the pods. Through discussion, develop the idea that each lima bean is a seed growing inside a ***seed pod.***

Next tell the class to look again at the second picture which shows "full grown" beans. Call on children to count the number of seeds in the open pod. Ask the class whether a lima bean plant has many or just a few seeds.

3. Now direct attention to the third picture and encourage the children to compare the seed shown in the picture with the dried beans that they have. Then ask the question:
Is there something inside the seed that looks like a tiny plant?

Tell the children to point to the beginnings of a new plant in the picture of the split bean. Call attention to the fact that this part, which may later become a complete plant, occurs at only one end of the seed. The tiny plant does not extend through much of the seed. **What is the purpose, or use, of the other part of the seed?**

You may need to explain that the new plant needs some food as soon as it begins to grow. It is not able to get outside food, so it uses food from its own seed. Have children point to the plain-looking part of the seed that serves as food for the new plant.

Through study and discussion of the pictures, lead children to the following understandings:

One lima bean plant has a great many lima bean seeds. Inside each seed is the beginning of a new plant and also food for the new plant when it starts to grow.

Then tell them to think about this question between now and the next lesson:
What kind of plant will grow from one of these seeds?

Extending the Concept

Through Investigation. Soak dried lima beans overnight. Give one to each child (or to a group of three or four) to split open. You may need to demonstrate the splitting process to prevent damage to the seed. Help children to find the beginning of a new plant and food for the new plant. Allow time for each child to use a magnifying glass to examine the "baby" plant and its first source of food.

Through Key Concept Words. Add *plant, seed pod,* and *seed* to the Science Vocabulary Chart.

Through Activity. Collect different kinds of beans: green beans, fresh and dried limas, dried navy, and kidney beans, etc. Display the beans, and develop the idea that each kind of bean grows on its own kind of bean plant.

Through Activity. Encourage children to bring in labels from cans and wrappers from frozen packages of various kinds of beans. Use these labels and wrappers to make a chart showing that we use beans as food.

Seeds come from a plant.

LESSON 2, page 63

SUBCONCEPT: Plants can reproduce their own kind through seeds.

Aim of the Lesson

To give children an opportunity to observe the sprouting of lima bean seeds and the growth of new plants.

Introducing the Lesson

SUGGESTED: a carton or closed jar of dried lima beans.

Have children review the last picture on page 62 to help them to recall that a seed contains the beginnings of a new plant and food for the new plant. Raise questions about the growth of the new plant, such as the following:

Does a dried bean that is kept in a carton or jar (in store or kitchen) grow into a new plant?

What has to happen before a new plant can grow from a lima bean seed?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: 7 lima beans that have been soaked overnight; 6 dry lima beans; a pint-size transparent plastic jar or tumbler; blotting paper to fit sides of tumbler; water to wet the paper.

Call on children to tell (from the colored bands) the kind of lesson they see on page 63. Then choose individuals to name, or point to, each of the items needed for today's investigation and pick up the item named.

What kind of plants will grow?

Let everyone see and feel the difference between the wet and dry beans. Demonstrate the removal of the tough outer coat of one seed that has been soaked. Let several children try to do the same with a dry seed. They will discover that they cannot "peel" the hard seed coats from the dry beans.

1. Next, call on a child to tell what is being done in the first picture. Choose someone to come forward and place the blotter around the inside of the tumbler. You may need to assist the child.

2. Choose other children to describe the placement of the seeds as shown in the second picture. Have these children come forward and insert the soaked bean seeds in the manner illustrated. The wet blotter will hold them in place. Preferably, the seeds should be about an inch below the top of the wet blotter and an inch and a half apart.

After the beans have been "planted," explain that a wet blotter is being used instead of soil because we want to watch the seeds.

3. Direct attention to the third picture and to the question on the pupil's page. Call on someone to describe the picture. Call on someone else to read the question. Ask about the time between the situations in the second and third picture. **Is it the same day, the next day, or several days later?**

The children see that a new plant is starting to push its way out of each seed that is in the tumbler. They may not know the *kind* of plants that are growing. Encourage them to make a prediction.

Introduce the word ***sprout***, and explain that each seed in the bottom picture is beginning to sprout. Ask whether the dry beans beside the tumbler are also beginning to sprout. **What makes the difference?** (Water.)

Through discussion, further study of the pictures, and examination of soaked and dry seeds, guide the class to these understandings:

Dry lima bean seeds do not sprout.

Lima bean seeds sprout when they get water.

When a lima bean seed sprouts, a new plant is growing out of the seed.

Extending the Concept

Through Following Up the Investigation. Keep the blotter wet by adding a small amount of water to the bottom of the tumbler as needed. Encourage children to observe the seeds each day. As soon as sprouting begins, have the class compare their investigation with the bottom picture on page 63. As soon as the plants are large enough, help children to compare their specimens with the lima bean plant shown on page 62.

Through Further Investigation. Let children, individually or in small groups, soak lima beans, other kinds of beans, sunflower seeds, or seed peas and make their own observation jars, following the procedure shown on page 63. Perhaps these investigations can be done at home.

Through a Field Trip. Take the class to a vacant lot or weed patch near the school (free of poison ivy and poison oak). Ask them to find a small plant. Pull or dig up a small, complete plant. Carry it back to the classroom and place it in a glass of water. Let children examine it and discover that a plant has roots, stem (or stems), and leaves.

Through Key Concept Words. Add *sprout* to the Science Vocabulary Chart.

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 2: Growing Plants in a Garden

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 3, pages 64 and 65

SUBCONCEPT: Seeds produce the kind of plants from which they came.

Aim of the Lesson

Children begin to realize that from each kind of seed comes its own kind of plant.

Introducing the Lesson

REQUIRED: commercial packets of bean, radish, lettuce or cabbage, carrot, and beet seeds.

Let the children handle the sealed packets of seeds to become familiar with the pictures of the vegetables and their names. Write the names on the board, and encourage children to tell about eating the various vegetables for lunch or dinner. Then tear open a corner of each packet, and let children examine a few of each of the different seeds.

What kinds of plants will grow from these seeds?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: packets of seeds described above.

1. Invite children to study the first picture on page 64. Have individuals come forward and pick up the packets of seeds, one by one, and match them with those shown in the picture. You may wish to fold over each torn corner and fasten with a paper clip to prevent the seeds from spilling out of the packet. Help the children to identify each of the vegetables by its picture and name.

2. Next have the children look at the bottom picture to find out what the boy and girl are doing. Guide their observations by presenting questions similar to these:

Where is the girl planting the seeds?

Which kinds of seeds are already planted? How can you tell?

Which kind is the girl planting now?

Which kind will she plant next?

How do the children show which kind is planted in each row?

Why is the boy putting water on the garden?

What kinds of plants will grow in this garden?

Through discussion of the pictures on page 64, develop these understandings:

Radish, cabbage, carrot, beet, and bean seeds are planted in ***soil.***

The soil is then watered. Water will soak into the seeds and make them sprout.

The sprouting seeds will grow into new plants.

3. Next, invite the children to look at the picture at the top of page 65 to find out whether or not there are plants growing in the garden. Ask a few guiding questions:

Is it light in the garden? What do you see shining on the new plants?

Do all the new plants in the garden look alike?

Are they all the same shape? Do they all have the same kind of leaves?

How many different kinds of plants do you see? (Have children count the rows.)

How many different kinds of seeds did the boy and girl plant? (Count the packets.)

From what you have learned about seeds and plants, can you tell why there are five different kinds of plants growing in this garden?

Encourage discussion of children's responses and guide the class to this generalization:

Each *kind* of seed grows into its own *kind* of plant.

4. Then have the children study the bottom picture on page 65 to see whether or not the radish seeds have grown into radish plants and the cabbage seeds into cabbage plants, etc.

Choose a boy to come forward and show, by holding up the proper seed packet, what he could pick from the row where the hands are shown. **Why do radishes grow in that row?**

What kinds of plants will grow?

Choose a girl to come forward and illustrate what has already been picked and placed in the basket. **From what rows were they picked? Why?**

Let other children demonstrate what is growing in the two rows from which nothing has been picked. In each case, ask: **Why does that kind of plant grow in that row?**

Now ask the class to imagine what may be done with the things that the boy and girl pick from their garden. For example, radishes and carrots may be part of a picnic lunch; cabbage may be used for a salad; beans used in a soup; and beets cooked for dinner. Through a brief discussion of various uses of these vegetable foods, the children will discover that we eat parts of some plants every day.

Have children describe the sequence of events in the garden as they are shown on the pupil's page.

a. Five different kinds of seeds are planted in the soil.
b. The soil is watered. The seeds soak up water.
c. The seeds sprout and grow into five different kinds of plants.
d. The Sun shines on the plants, which grow bigger and bigger.
e. Parts of the plants are ready to be used for food. In this case the food consists of bean *seeds* and *seed pods*, radish, carrot, and beet *roots*, and cabbage *leaves*. (See Extending the Lesson.)

To appraise the childrens' understanding of the lesson, discuss problems such as these two:

Sam had a small field in which he had planted corn seeds and raised sweet corn for several years. This year, when he was ready to plant, he found that he had been sent bean seeds instead of corn seeds. So Sam planted bean seeds in what had been his corn field in other years. **What do you think grew in Sam's field this year? Why did he have no corn? Why did he have bean plants instead?**

Marilyn wanted to grow some pretty flowers in a flower pot. She bought some flower seeds. She filled the flower pot with dry soil and planted her seeds in the soil. Then she put the flower pot in a place where it would get sunlight. She watched and waited, but no plants came up. **What was wrong? What did Marilyn forget to do?**

A discussion of the answers provides a good opportunity to reinforce the understandings that a seed produces its own kind of plant and that water is needed for seeds to sprout.

Extending the Concept

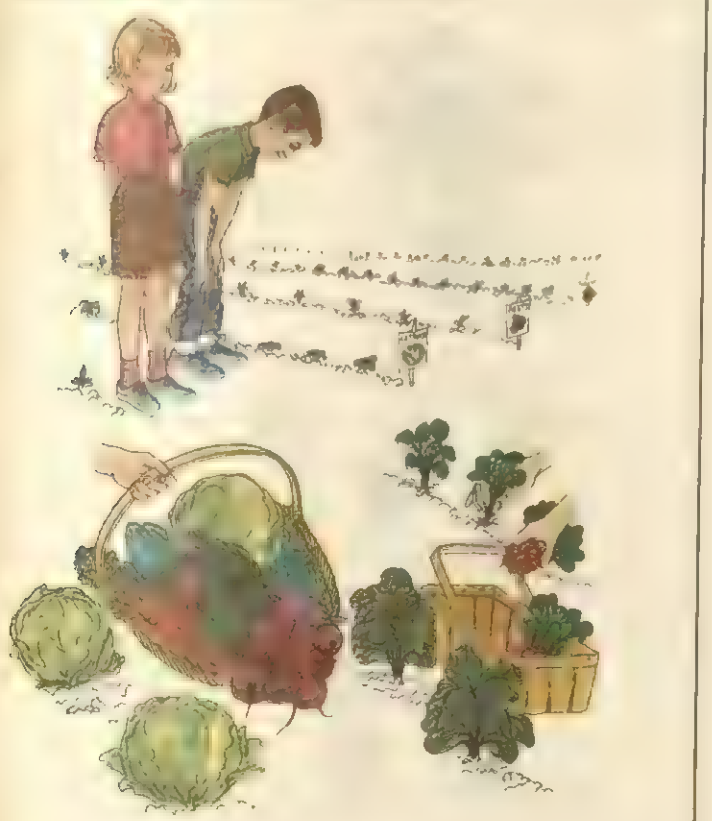
Through Activity. Choose volunteers to bring in various fresh vegetables: carrot, beet, turnip, radish (each complete with "top"); several green beans and fresh peas (in pods); stalk of celery, and piece of asparagus; several leaves of spinach, lettuce, and cabbage. Exhibit the fresh vegetables on wet paper toweling. Then use them to help children to discover which parts of the various plants we use as food:

carrot, beet, turnip, radish (roots)
green beans (seed pods and seeds)
peas (seeds)
celery, asparagus (stems)
spinach, lettuce, cabbage (leaves)

Through Key Concept Words. Add *soil* to the Science Vocabulary Chart.

Through Investigation. Using some of the seeds from opened packets, make a windowsill vegetable garden. Make planters from half-pint milk cartons by cutting off the top and filling with good garden soil. Plant a few of one kind of seed in a single planter. (If good soil cannot be dug from the school garden, a local nurseryman may supply it. He may also be willing to offer some suggestions on how to plant seeds and to care for indoor plants.)

Each carton should have a drainage hole punched in the bottom. After the seeds have been planted (directions are generally given on the packet), water gently with a toy sprinkling can or with a sprinkler such as is used for dampening clothes. Protect windowsills by standing the cartons in aluminum foil pans that the children can bring to class.



What kinds of plants grew?

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 3: New Plants from Cuttings

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 4, pages 66 and 67

SUBCONCEPT: Some plants can reproduce new plants from parts of the old.

Aim of the Lesson

To give children the opportunity to discover that a part of a plant can grow into a new plant of the same kind.

Introducing the Lesson

REQUIRED: bean plants or sprouting seeds (from investigation in Lesson 2, page 63).

Give all children the opportunity to examine the tumblers to find out how the seeds are changing. **Have *roots* grown yet? *Stems? Leaves?* Have complete plants grown from any of the seeds?** Help children, through observation and discussion, to realize that new lima bean plants are growing (or have already grown) from the lima bean seeds. Then present the question:

Can a new plant be started in some other way?

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: blossoming geranium plant, 4 pots, garden soil.

1. Direct attention to the picture at the top left of page 66. Call on someone to identify the plant shown in the picture. Say the word *geranium*. If there is a blossoming geranium plant in the room, help children to compare it with the one in the picture, noting the color of the flowers in each case.

Choose a child to describe what is happening in the picture at the top of the pupil's page. Through appropriate questioning, get the children to see that pieces of stem, with some leaves, are being cut from the plant. The cut pieces are then placed in a glass of water as shown at the right. After the children study the pictures, cut four shoots from a geranium. Plant one. Ask for volunteers to plant the others. Discuss instructions for their care.

2. Ask the class to look at the middle row of pictures. **What has grown from each of the pieces of plant that was placed in the glass of water? Does each piece now have roots? Does it have a stem and leaves, also? Is it still only a piece of a plant? Is it now a new plant?**

Through discussion of the questions above, guide children to these understandings:

In water, the pieces of geranium plant grew roots.

Each piece now has roots, stem, and leaves.

Each piece is now a complete new plant.

Referring again to the middle row, ask what is being done with the new plants. Children will see that they are being planted in soil in flower pots.

3. Now have the class look at the pictures at the bottom of the page to see how the new plants have grown. Ask them to point to the two new plants and then to the plant from which the pieces of stem were cut.

To emphasize the main points of the lesson, present the following questions:

What did the new plants grow from?

What kind of plant did the stems come from? What color flowers did the plant have?

What kind of plants are the new plants? What color flowers do they have?

Through discussion of the answers and further study of the pictures, children will realize that the parts of the red geranium, which were cut from the plant, grew into new plants; and that the new plants are red geraniums, the kind of plant from which the cuttings were made. Once the children understand how new plants are grown from cuttings, suggest that they follow the same technique in class or at home.

4. Next, direct attention to pupil's page 67 and identify the plant in the first picture as a *pussy willow*. Encourage children to discuss the plant and to discover that it is called *pussy* willow because flowers on the stems are soft and silky like a "pussy cat." Through questioning, establish the fact that someone is cutting pieces of stem (or twigs) from the pussy willow plant.

From what do they grow?

5. Call on someone to describe what is being done with the new plants in the middle row. Children will see that the plants are being placed in soil outdoors. Now challenge the class by asking whether they think the new plants are bean plants or geranium plants or some other kind.

6. As children state their opinions, tell them to look at the bottom row on the page. **What kind of plants do they see growing in the garden? Why are they pussy willow plants rather than something else?**

By now, some children will be ready to generalize:

Some plants can make more of themselves from pieces of stem.

Each piece can grow into a whole new plant.

The new plant is the same kind as the plant from which the piece of stem was taken.

You may wish to explain that all flowering plants can be grown from seeds. Geraniums and pussy willows (and quite a few other plants) can also be grown from "cuttings"—pieces of stem — as shown on pages 66 and 67.

To determine the success of the lesson, let children discuss and explain problem situations such as these two:

Pat wanted to grow a *pink* geranium for his mother's birthday. He cut a piece of stem from a geranium plant that had big *red* flowers. He put the stem in water and it grew into a new plant. **Did the new plant have pink flowers? Why not?**

Linda cut off a piece of stem from a pussy willow and stuck it through the cover into an empty candy box. She waited several days to see if roots appeared. When no roots grew, she filled the box with sand. **Did the piece ever grow into a new pussy willow plant? Why not?**

From what do they grow?

As children give their answers, encourage them to explain in terms of a plant making more of its own kind, and of water being needed for plant growth.

Extending the Concept

Investigation 1. In early spring, obtain a few pussy willow branches, *cutting* them cleanly from full grown shrubs or buying them from a florist. Trim the cut ends under water, and then dip each branch in lukewarm water to loosen the waxy coating. Arrange the branches in water-filled jars or vases, and keep them in water until roots are well developed. The new pussy willows can then be planted in the school garden, where they will become a resource for science classes every spring.

Twigs cut from forsythia and from privet hedges will also develop roots and grow into new plants when placed in water.

Investigation 2. Grow new geranium plants by following the procedure shown on page 66.

Investigation 3. To show that a whole new plant can grow from a leaf, use the leaf of a rex begonia (nontuberous begonia). Make slits in the edge of the leaf at junctions of large veins. Place the leaf, top surface down, on some damp sand. Fasten the leaf in place with toothpicks, and cover it with an inverted glass or a transparent plastic jar. This will keep it moist. Encourage children to watch the leaf each day. Soon they will see the new roots growing out from the slits.

New plants can also be grown from the leaves of bryophyllum ("air plant" or "live forever"); from coleus (showy foliage herb); and from pieces of the bladelike leaves of sansevieria ("snake plant") inserted, cut end down, in damp sand or soil.

Investigation 4. To show that plants can grow from parts of roots, use the following root vegetables: radish, beet, turnip, and carrot. Cut off each root about an inch from the top, leaving some of the small stems and leaves extending from the root top. Then place these root tops in a tray of pebbles or commercially available vermiculite. Put enough water in the tray to cover the bottom half of the root part. Soon there will be fresh green growth from the old roots.

Investigation 5. Buy narcissus bulbs in late winter or early spring. Imbed the root ends in a shallow container of pebbles, with just enough water to keep the root ends wet. To insure well-developed roots, keep the bulbs in a dark, warm place until the first growth is visible at the tops of the bulbs. Then bring the container of bulbs into the light, where the plants will grow rapidly and blossom early.

Through Key Concept Words. Add *roots, stem,* and *leaves* to the Science Vocabulary Chart.

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 4: How Molds Grow

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 5, page 68

SUBCONCEPT: Some plants reproduce new plants from spores.

Aim of the Lesson

To give children the opportunity to compare mold plants with the more familiar green plants.

Introducing the Lesson

REQUIRED: a moldy fruit. (If none is available at home or at school, a moldy orange or lemon can usually be obtained at a food market.)

Put the moldy fruit in a small open box or a plastic bowl and let children pass it around. Invite them to examine the mold, notice its color, and how it covers the outside of the fruit. Encourage them to wonder about the strange, fuzzy coating by asking:

What is on the fruit?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a moldy fruit (same as above); a magnifying glass.

1. Direct attention to the picture at the top left of page 68. Call on someone to explain that a good, fresh orange is being placed in a covered box. Tell the children that the orange is pushed to the back of the box where it is dark. Then the flap at the front is closed and held in place with tape.

What happens to the orange after it has remained for several days in the dark box?

2. Tell the children to look at the right-hand picture at the top of the page to find out. Introduce the word ***mold.*** Explain that mold begins to grow in one or more places on the orange and then keeps spreading over the surface.

Have the children compare the mold they see in the picture with the mold on the fruit in the classroom.

Explain that mold is a kind of plant; that the orange is moldy because mold plants are growing on it. As the mold plants grow, they make more and more mold plants.

3. Now have children study the left picture at the bottom of the page. Call on someone to tell what is being used to look at the fruit in the picture. Then, let children take turns using a magnifying glass to look at the classroom specimen of moldy fruit. Direct attention to the way in which many mold plants are growing close together on the fruit. A single, separate mold plant cannot be seen by using a magnifying glass.

4. Have the children look next at the last picture to find out what *one* mold plant looks like. Explain that this picture shows the mold plant much, much bigger than it really is. As children study the picture, ask:

Does a mold plant look like any of the other kinds of plants we have been studying?

Does a mold plant have any green leaves? Any green stems?

Now direct attention again to the first picture on the page and ask: **Was the orange left in a dark place or in a light place; in a very cold place or in a rather warm place?**

Through discussion of the answers, guide children to the following understandings:

Mold plants do not have green stems or green leaves like other plants.

Mold plants can grow on fruit; they can grow where it is dark and warm.

Extending the Lesson

Through Key Concept Words. Add *mold* to the Science Vocabulary Chart.

Through Activity. Give children wax paper bags several days in advance of the lesson and ask them to bring in pieces of discarded food. Keep the specimens in a warm, dark place until time to use them in the investigation described in Lesson 6.

What grows on the orange?

LESSON 6, page 69

SUBCONCEPT: Some plants reproduce new plants from spores.

Aim of the Lesson

To give children an opportunity to observe how mold plants grow and reproduce.

Introducing the Lesson

REQUIRED: a few samples of the foods (now moldy) brought in by the children; several large magnifying glasses.

Call on children to come forward and take turns using magnifying glasses to look at the mold on the foods. Suggest that we do not like mold to grow on our food and we try to prevent it. Raise the following questions:

How do mold plants get started?
What helps them to grow?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED (for each mold garden): one aluminum foil pan; one piece of moldy fruit; several pieces of different kinds of fresh foods. Arrange these on a table in the front of classroom.

1. Invite children to look at the colored strip on page 69. Call on a volunteer to name the various things that are pictured for use in the investigation. Then choose children to come forward, one at a time, and pick up the needed materials from the table.

What kind of plants are growing?

2. Next, ask the class to study the picture under the investigation strip to see how the materials are to be used. Let children arrange pieces of nonmoldy foods around the moldy fruit in the manner shown in the picture. A child who has touched the moldy fruit should not touch the fresh foods.

Make sure that the children recognize that some fresh foods touch the moldy fruit and some fresh foods touch only each other.

Through discussion and the use of a magnifying glass, establish the following:

Mold plants are growing on the fruit in center of the pan.
No mold plants are growing on any of the other pieces of food in the pan.

Ask children about the sort of place to put the pan for a good growth of mold plants. Help them to recall from the top picture in Lesson 5 that mold grows where it is dark and warm (not necessarily in a box). Then let them choose a suitable place for their mold garden.

Ask what they think will happen to the foods on the pan. **Will the mold plants grow on just the piece of fruit on which they are already growing? Do you think that the mold plants spread from one food to another?** Encourage children to discuss and argue these questions, giving reasons for their answers.

3. Then have them study the final picture on the page to see what happened in the mold garden. Guide children to assumptions such as these:

Mold plants grow on foods when conditions are right for their growth (warm and dark).
Mold plants make more mold plants; the new plants are like the old plants.
As mold plants make new plants, they spread from one food to another.
Mold plants grow sooner on foods that touch food that is already moldy.

Remind the class that they will have to look every day at the mold garden they made to see how the mold plants grow and spread.

Ask the children: **Where are the mold plants shown on page 68 getting food? The mold plants shown at the bottom of page 69? The mold plants on the various pieces of food contributed by the children?** Through discussion, fix firmly these ideas:

Mold plants get food from the foods they grow on.
Mold plants cannot make their own food.

We put food in a refrigerator to keep it fresh. It is dark inside the refrigerator. **Why does mold not grow well inside the refrigerator?** (Too cold.)

Extending the Concept

With Rapid Learners. Introduce the word ***spore.*** Refer to the illustrations at the bottom of page 68 to help explain that the dark spots on the mold plants are little bags or sacs that are filled with very tiny spores. When the spores are ripe, the bags burst open, filling the air with spores. These spores are so small that we cannot see them. Any spore that lands where conditions are favorable (warmth, moisture, absence of light, and source of food) grows into a new mold plant.

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 5: Grass Plants from Seeds

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 7, page 70

SUBCONCEPT: Seeds produce the kind of plants from which they came.

Aim of the Lesson

To provide opportunity for children to observe how grass-plants grow; to help them identify cereal plants as grasses.

Introducing the Lesson

REQUIRED: a complete grass plant, with roots visible in a glass of water (if possible, secure a plant in flower or seed stage); hand lens magnifying glasses.

Let children take turns using magnifying glasses to examine the parts of the *grass* plant. Tell them where the plant was growing when you dug it up. Lead the class into a brief discussion of grass, which grows in so many different places. Encourage them to wonder about:

How do grass plants get started?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the first sponge in the top picture on page 70. Help children to read *oats* on the card standing in the sponge. Call on someone to tell what has been done with the oat seeds. Ask what will happen to the oat seeds when they get wet. Encourage children to reason that the wet seeds will sprout and then grow into new oat plants. Discuss foods (oatmeal, dry oat cereals, etc.) that are made from the seeds of oat plants.

2. Next, ask what kind of seeds are being "planted" on the wet sponge in the middle of the pan. Ask what will happen to the corn seeds that are "planted" in the middle sponge. Children will reason, from experience, that the corn seeds will grow into new corn plants.

Invite the class to tell about various corn foods they like to eat. Ask what part of the corn plant we use for food.

3. Then direct attention to the third sponge at the top of page 70. Ask for a volunteer to read the label by the sponge and tell what kind of seeds are to be "planted" on that sponge. Help children to understand that these seeds are the kind we use to grow lawns. **What kind of plants will grow from the grass seeds?**

Through discussion of the top pictures, guide children to the following assumptions:

When the seeds get water, they will sprout and grow into new plants.

Each kind of seed will grow into that kind of plant.

4. Have the children study the picture at the bottom of the page to find out what has happened to the seeds. Help them to read the question: **What kinds of plants are growing?**

If no one notices that all of the plants look somewhat alike, guide them to this observation by direct questions.

As the observations are made, explain that oats, corn, and grass belong to the grass family. Encourage children to compare the leaves (or "blades") with those on the bean plants growing in the classroom (or in Lesson 1, page 62).

Children will probably mention other kinds of grass plants whose seeds are commonly used for food: rice, wheat, rye, barley. Invite different pupils to tell of foods they like that are made from some of these "grass seeds."

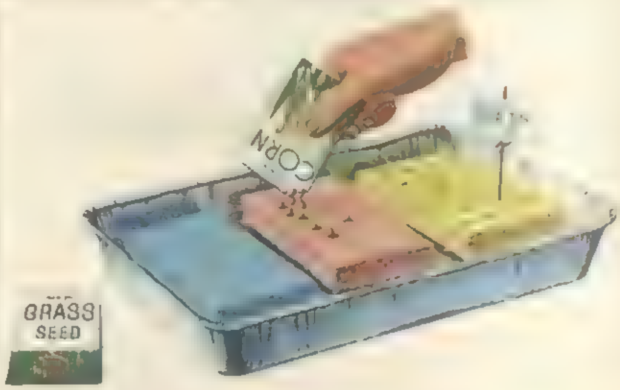
Develop the understanding that plants and seeds of the grass family are important sources of food.

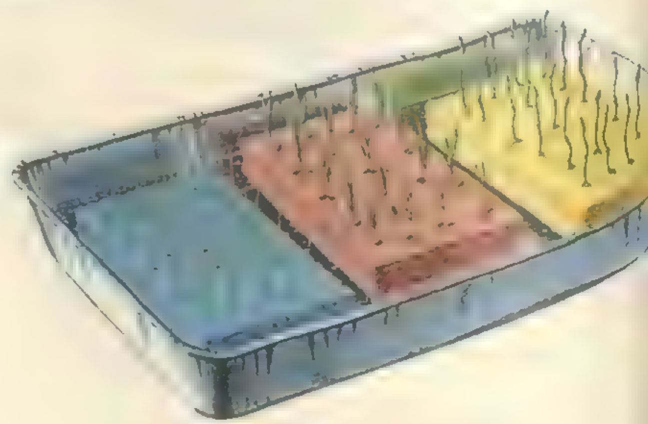
Extending the Concept

Through Investigation. Get seeds of cereal plants (oats, corn, wheat, rye) from a feed store. Let children sow them on damp sponges, as shown on page 70.

Through Key Concept Words. Add *grass* to the Science Vocabulary Chart.

Through Activity. Put a handful of wheat seeds (or cracked wheat from a health food store) between two layers of clean cloth on a smooth stone or concrete base. Demonstrate how to use a hammer to pound the seeds. Shake the meal through a fine sieve (or flour sifter), and let children see that a kind of flour can be made from seeds.





What kinds of plants are growing?

Section 6: New Plants from Seeds in Fruits We Eat

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 8, page 71

SUBCONCEPT: Seeds produce the kind of plant from which they came.

Aim of the Lesson

Children discover the purpose of the seeds found in common fruits.

Introducing the Lesson

REQUIRED: at least one fruit (apple, orange, grapefruit) that can be cut open to reveal seeds.

Invite children to mention their favorite *fruits*. **Do you like apples, pears, cherries, grapefruit, peaches, plums?** Ask what they find inside each of these fruits. Cut open the sample fruit, and let children remove and examine some of the seeds. Through discussion, develop the idea that ordinarily these seeds are not used for food.

What are fruit seeds used for?
Are all fruit seeds alike?
How are they different?

What kinds of plants will grow?

Developing the Concept

(by emphasis on the subconcept)

1. Have children look at both pictures at the top of page 71 to see what the boys are eating. Most children will recognize grapefruit and watermelon. Through questioning, bring out the following understandings:

Grapefruit and watermelon are fruits. They come from flowers.

If you are near an orchard or a gardening area, you may wish to develop the idea that such fruit as apples, peaches, and grapefruit grow on trees; and that such fruit as melons, tomatoes, cucumbers, and pumpkins grow on vines.

Now ask the children to look again at the two pictures at the top of the page. Call on children to tell what each boy is saving from his fruit. Encourage children to recall eating grapefruit and watermelon. Have them explain whether or not they found seeds in both kinds of fruit, and what they did with the seeds they found. Then ask:

What do you think the boys in the pictures are going to do with the seeds they are saving?

2. To verify answers to the question, have children look at the pictures at the bottom of the page. There they will see that the two boys are planting the seeds they saved.

Call on someone to read the question on the page: What can the children grow? Then ask:

What can the first boy grow from his grapefruit seeds?

What can the second boy grow from his watermelon seeds?

3. Prepare milk-carton planters. (See page 65.) Let children plant seeds from grapefruit, and from melons, squash, or pumpkins, to grow young trees and vines.

Develop the following understandings:

Fruits come from plants.
There are seeds in fruits.
The seeds can grow into new plants.
Grapefruit seeds grow into grapefruit plants or trees; watermelon seeds grow into watermelon plants or vines.

Many children may be ready to generalize as follows:
Seeds grow into plants like the plants they came from.

Extending the Concept

Through Investigation. If it is possible in your locality, have someone bring in an avocado seed that already shows a sprout. Explain that there is only one seed in each fruit, as in a peach or a plum. Place the seed, wide end down, in a small glass with enough water to cover the bottom half of the seed. (If unsprouted, keep it in the dark for a few weeks. As soon as the seed splits and shows growth at the top, bring it into the light.) After roots, stem, and leaves are well developed, put the plant in soil for an attractive indoor tree.

Through Key Concept Words. Add *fruit* to the Science Vocabulary Chart.

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 7: New Plants from Dispersed Seeds

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 9, page 72

SUBCONCEPT: Plants are dispersed to new environments by means of seeds.

Aim of the Lesson

To provide children with enough experiences to realize that new plants are started in new environments from seeds that are carried by animals and other agencies such as wind and water.

Introducing the Lesson

Take children on a short field trip to discover plants growing in many kinds of places. Call attention to seeds and grasses in vacant lots, between rocks and cracks in pavement, and in other areas where obviously no one took the trouble to plant them. Lead children to wonder:

Why do so many kinds of plants grow in so many places?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the top picture on page 72. Call on someone to tell the story of what the squirrel is doing. Pass acorns around the class if specimens are available. To bring out the essential features of the picture, present questions about the source of the acorns, their relation to the ***tree***, the time of year, and why the squirrel is burying the acorns. Develop these ideas:

Acorns are seeds of the oak tree.

Squirrels use acorns for food.

In the fall squirrels store acorns for winter use.

Some of the acorns buried in the ground remain there because of frozen ground, snow, or even forgetfulness on the part of the squirrel.

Now challenge the class by presenting this question: **If some of the acorns stay buried all winter, what happens to them when the snow melts in spring, the ground thaws, and the water soaks into the soil?**

To verify answers, refer children to the seedlings in the top picture. Identify the seedlings as young oak trees, and check for comprehension by presenting questions such as:

Why are young oak trees growing here?

What are the new oak trees growing from?

Can you explain how the acorns got "planted"?

Encourage answers that reveal the relation between seeds (acorns) buried by a squirrel and new oak trees.

2. Then direct attention to the picture at the bottom of the page. Call on individuals to tell what is happening in the left part of the picture. Try to bring out the following ideas:

The burs sticking to the boy's clothes are seeds.

The boy pulls off the seeds, which fall on the ground.

Some of the seeds grow into new plants that have burs.

The plant at the left of the picture is a full-grown plant with seeds (burs).

3. Almost every child will recognize the dandelion, and that the wind is blowing seeds from the head. Ask: **Do you think that new dandelion plants will grow near here? Do you think anyone planted dandelion seeds where these plants are growing?**

Through review develop the following understandings:

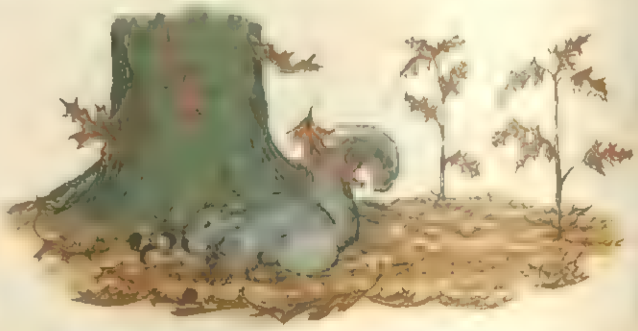
New plants grow in new places from seeds that are carried there by animals, by people, and by the wind.

Each plant is like the plant on which its seed grew.

Extending the Concept

Through Investigation. Collect several intact dandelion seed heads. Pull out the "parachutes" and let children examine them through a magnifying glass to discover why the seeds float so easily on the air. Count aloud with the children as you remove the seeds. **What would happen if every seed grew into a new plant? Why do some not grow?**

Through Key Concept Words. Add *tree* to the Science Vocabulary Chart.



What is happening?

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 8: Energy for Growth of Plants

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 10, page 73

SUBCONCEPT: The Sun is the source of energy for the reproduction and growth of the green plant.

Aim of the Lesson

To give children experiences which lead to the discovery that green plants need sunlight.

Introducing the Lesson

REQUIRED: several Irish potatoes with conspicuous eyes. If some already have shoots, so much the better.

Pass the potatoes around and let children examine the eye spots. Encourage them to speculate about the purpose of the eyes. The purpose is more readily seen if shoots are present. Stimulate curiosity about how potatoes grow. Lead up to the question:

What would happen if we planted a potato eye?

Should a potato eye be planted in a light place or a dark place?

Why are they different?

73

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: an Irish potato with eyes; a paring knife; a small sprinkling can; two pots, marked *A* and *B*, containing good garden soil.

1. Direct attention to the strip at the top of page 73 and call on someone to tell what is needed for the investigation. Ask someone to tell what has been done to the potato. (Pieces with "eyes" on them have been cut away.) Then cut pieces from the potato as shown in the illustration. Let the children see the "eye" in each piece that you have cut.

2. Refer children to the picture just below the strip. Choose one child to come forward and plant a piece of potato in pot *A*. Have another child plant a piece in pot *B*. Encourage the class to study the picture to see that the planting is being done properly.

Ask what the sprinkling can is for. Let a child fill the sprinkler and water the two pots till the soil is damp.

3. Now guide attention to the right-hand picture in the second row. Ask where pot *A* is standing. **Is it in a light place or in a dark place?** Let the class decide on a suitable light place in the classroom for pot *A*. Have someone move pot *A* to the chosen spot.

Ask where pot *B* is being placed in the right picture. Then let the class choose a suitable dark place for pot *B* and have someone put the pot in that place.

Now have the children turn their books face down while they speculate briefly about these questions:

Will new plants grow in our two pots? What will the plants grow from?

What kind of plants will they be?

Do you think that the new potato plants in pot *A* and pot *B* will be just alike, or will they be different?

Now direct attention to the picture at the bottom of page 73. The children will see that plants are growing in both pots. Call on someone to read the question on the page. Now ask questions about the appearance of the plants to help the children to summarize their observations:

New potato plants grew from the "eyes" of the potatoes.
The plant that grew in the light looks green and strong.
The plant that grew in the dark looks pale and weak.
Light (from the Sun) makes green plants grow well.

Extending the Concept

Through Following Up an Investigation. At the same time each day, let the class observe what is happening in the two pots, *A* and *B*. After leaves have developed, compare both pots with those in the picture on page 73. If the class investigation does not turn out like the one in the textbook, help children to find reasons for any differences that occur. (Poor potato; too much, or not enough water; room too cold at night; etc.)

Through Key Concept Words. Add *potato eye* to the Science Vocabulary Chart. Reemphasize the words *light* and *energy*.

UNIT SEVEN: PLANTS AND MORE PLANTS

Section 9: Summary and Evaluation

CONCEPT SUMMARY
Organisms (living things) reproduce their own kind. New plants are produced from seeds and spores, or from parts of the old plant.

LESSON 11, page 74

Aim of the Lesson

To give children an opportunity to summarize their understanding of plant reproduction by applying it to new situations.

A New View of the Concept

REQUIRED: various kinds of plants growing in the classroom.

Call on children to discuss each of the various classroom plants. Encourage them to tell how each got started, mentioning the kind of plant the seed (or cutting) came from. Lead up to the question:

When any seed (or cutting) sprouts, what kind of plant grows from it?

Fixing the Concept

As children look at page 74, explain that we will use The Big Idea of our study of plants for a "plant hunt" game with the pictures on the page.

1. Begin the game by calling on a child to name the first fruit. Call on another child to tell where he sees the apple cut in half and to tell what he sees inside the fruit when it is cut open. Have all children put their fingers on the apple seeds. Write the word *apple* on the board.

Ask what happens when apple seeds are planted. **What does an apple seed grow into?**

Now ask the class to find a branch of the tree that grows from an apple seed. Call on a volunteer to point to part of the plant (branch) in the left column on which apples grow. Have all children point to the picture of the apple branch.

Then proceed with the other fruits on the page, using questions and comments like those suggested below:

2. Who can find a peach? (Write *peach* on the board.) **Where is the peach seed shown? How many seeds are there in one peach? What do we do with peaches? What can we do with a peach seed? Can you find the branch on which peaches grow?**

3. Continue the game with the orange, cherry, and pear, but vary the questions somewhat in each case.

4. Repeat the game, this time skipping around, rather than taking the fruits in order from top to bottom.

Children will also enjoy doing the exercise in reverse. Instead of "a plant hunt," have "a fruit and seed hunt." Begin by having children identify a branch, then the fruit that grows on that branch, and the seed from which the tree grew.

Continue the game until each child has had a chance to participate at least once.

To establish the main concept of the unit, "Plants reproduce their own kind," call on children for responses to a number of different questions similar to the following examples:

Bean seeds grow into (what kind of) plants?
Wheat plants grow from (what kind of) seeds?
Potato "eyes" grow into new (what kind of) plants?
A stem from a pink geranium plant grows into a new geranium plant that has (what color) flowers?
If a squirrel buried a peach seed, could an oak tree grow from it? What kind of tree could grow?

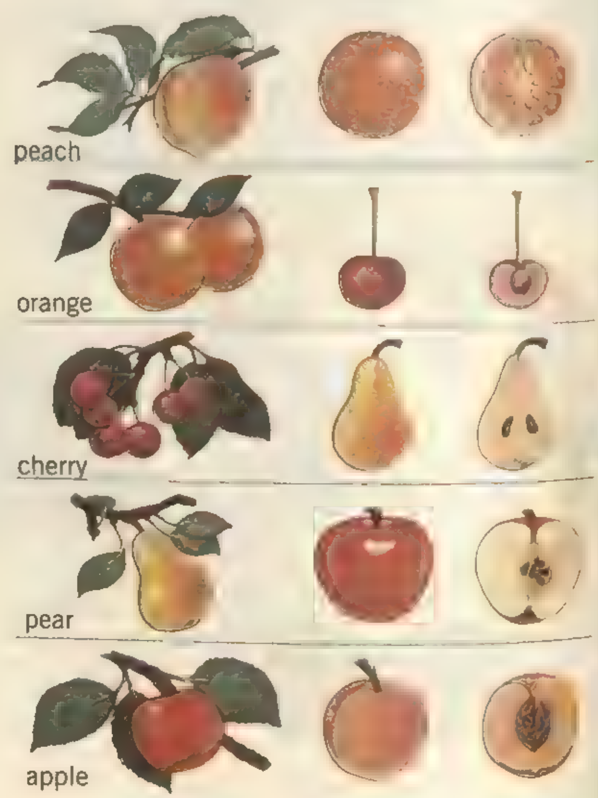
Finally, give the class a few minutes to look through the entire unit, pages 62–74, to encourage a feeling of pride in what they have learned about plants.

5. During a language lesson, conduct an oral review of the Unit Seven words on the Science Vocabulary Chart: plant, sprout, soil, tree, flower, roots, mold, potato eye, seed pod, stem, grass, seed, leaves, fruit.

6. Make a garden for water plants in a large glass pickle jar or an aquarium. Fill with pond, stream, or rain water. If only tap water is available, first let it stand for at least three days to remove most of the chlorine. Put a layer of thoroughly washed sand on the bottom. Water plants are available at aquarium supply shops or dime stores.

If it is spring and tadpoles are available, add a few. Otherwise, guppies are recommended. Consult your pet store dealer about food and care for tadpoles or guppies.

THE BIG IDEA



74

UNIT EIGHT: ANIMALS AND MORE ANIMALS

Children delight in aquarium life; in raising tadpoles; in observing garden snails and caterpillars biting and tearing leaves as they feed; and in watching beetles and other kinds of insects in observation jars.

Every classroom needs live animals of some kind. The animals need not be large ones, nor necessarily ones that become major projects of feeding and housing.

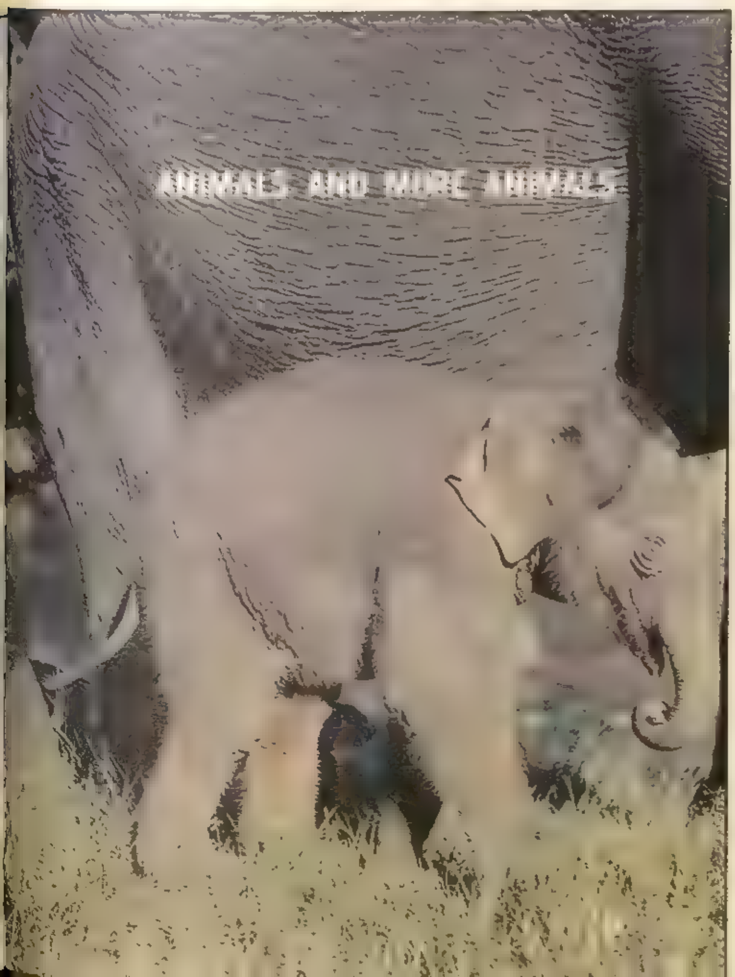
Most young children know that chicks hatch from eggs and that young birds come from the eggs in a bird's nest. On farms and ranches, the arrivals of calves, lambs, and other baby animals are important events that are known about by children; and in the city, children have pet dogs and cats that produce litters. Young children's acceptance of the birth of animals is natural and wholesome.

The major conceptual scheme is the same as for Unit Seven. The concept for this unit is that animals reproduce their own kind.

New Animals from Eggs. Many kinds of animals lay eggs. An egg, like a seed, contains the beginnings of a new organism and food for the early stages of the organism's growth.

Each egg-laying animal lays eggs that are characteristic of its kind: hard, brittle shells for birds; tough, leathery shells for turtles and most other reptiles; gelatinous strings and jellylike masses for toads and frogs.

However different the eggs of animals are in size, color, form, number, and occurrence, they are all alike in purpose: they provide for new animals of their own kind.



Animals and Their Needs. In Unit Seven, we were concerned mainly with plants. Now, in Unit Eight, we shall deal with living things that are clearly identified as animals. Animals have certain characteristics in common: they can move from place to place; they breathe and eat food; they grow and reproduce their own kind.

In order to live, animals have certain needs, which must be supplied in their surroundings if they are to survive. They need warmth, food, air, water, and some kind of either shelter or protection. The degree of warmth, kind and amount of food, amount of air and water, and type of shelter needed varies among different animals and even among animals of the same kind.

Classes of Animals. A number of kinds of animals are presented in Unit Eight to help to develop the concept of each reproducing its own kind. The various animals pictured and described fall into six main classes. While classification is not a major purpose of the unit, children may be encouraged to observe certain characteristics that are typical of animals in any one class.

1. *Fish* have scales, live in water, and breathe by means of gills. Most fish lay eggs. Guppies, which may be raised in the classroom, have "baby" guppies.

2. *Amphibians* (frogs, toads) lay eggs in water. Tadpoles hatch from the eggs and live a fishlike existence, breathing with gills. The tadpoles change, grow lungs, and move out of the water. They become adult amphibians, living on land.

3. *Reptiles* (snakes, turtles, lizards) are covered with scales or scaly plates. Most species lay eggs, but the common garter snakes have "baby" snakes. The eggs, which are laid on land, are enclosed in skinlike shells. Reptiles breathe with lungs.

4. *Birds* lay hard-shelled eggs, usually in nests. The nests may be mounds of mud, piles of rocks, excavations in sand, or the more common type made from plant materials. All birds have wings, even nonflying birds like the penguin. Birds have feathers on their bodies and breathe with lungs.

5. *Mammals* have bodies that are usually covered with hair or fur, and breathe with lungs. Most mammals have legs and/or arms, and have baby young. A few, like the spiny anteater, lay eggs.

All of the kinds of animals mentioned (fish, amphibians, reptiles, birds, and mammals) have backbones.

6. *Insects* are egg-laying animals without backbones. As the insects grow from the eggs, they pass through distinct forms. Moths and butterflies, for instance, change from egg to *larva* (caterpillar), from larva to *pupa* (quiet stage), and from pupa to adult. Some insects, like the grasshopper and cricket, go from egg to *nymph* (immature insect), and from nymph to adult. All adult insects have six legs and bodies that are separated into three parts (head, thorax or middle part, and abdomen or end part).

Spiders (not studied here), have eight legs and two-part bodies. They are readily recognized as noninsects. Other nonbackbone animals are snails, earthworms, starfish, etc. They have various methods of reproducing young.

UNIT EIGHT: ANIMALS AND MORE ANIMALS

Section 1: Animal Offspring

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 1, page 76

SUBCONCEPT: Some animals reproduce their own kind through eggs laid externally.

Aim of the Lesson

Children become aware of the fact that a chicken hatches from a hard-shelled egg and that the young chicken is like the parent chickens.

Introducing the Lesson

REQUIRED: one hard-boiled egg.

Show the ***egg*** to the class and through questioning develop the understanding that the egg came from a ***chicken.*** Explain that the egg has been cooked (hard-boiled) so that the inside parts may be seen more easily. Call on some child to peel the egg. Then cut it and take it apart. Call attention to the outer shell, the shell lining (membrane), the white, and the yolk.

We cook eggs and use them for food. **What else are eggs used for?**

Developing the Concept

(by emphasis on the subconcept)

1. Invite children to study the upper picture on page 76. Call on someone to tell what is coming out of the egg. Introduce the term ***hatch*** and explain that the young chicken grows inside the egg until it is big enough to come out, or hatch. Then it pecks a hole in its shell, cracks the shell open, and hatches from its egg.

2. Help someone to read the sentence in the middle of the page. Let the children know that they are now going to choose the animal on page 76 that is the young chicken's parent. Look at the bottom of the page. Have someone tell what kind of animals are shown in the four pictures.

Ask the name of the first animal. **Could it be the parent?** As children reply in the negative, have them give reasons for their answers.

Repeat the question and discussion for each of the animals at the bottom of the page: blue jay, owl, duck, and chicken.

After the class picks the chicken as the ***parent,*** encourage several children to tell about kinds of ***birds*** they know. (Do not, at this point, develop the characteristics of birds. This will be done later in the unit.)

Through discussion of the egg, the emerging chick, and its parent, lead to the following understandings:

The chicken came from a hard-shelled egg.
The young chicken is like the parent that laid the egg.
Chickens are birds and birds lay eggs.

To evaluate the success of the lesson, present the following problem for discussion:

A boy had five eggs that were ready to hatch. He thought they were chickens' eggs and expected to get five young chickens. To his surprise, he got four young chickens and one young duck. **How could this happen?** (One egg had been laid by a duck.)

Extending the Concept

Through Investigation. If possible, obtain a fertilized fresh egg from a hatchery. (Egg purchased in a store may not be fertilized. Do not discuss fertilization.) Break open the egg and place it in a dish. Help children to observe the similarity between an egg and a plant seed. Point out the small reddish brown dot (the beginning of a new chicken), and the yolk and white, which serve as food for the chick while it is growing inside the egg. Explain that the shell, like the seed coat, protects the inside parts and holds them together.

(NOTE: Assure children that the eggs we eat are not ready to develop into chicks. This may prevent children's refusal to eat eggs; it has been known to happen.)

Through Key Concept Words. Begin a new Science Vocabulary Chart. Head it "Animal Words We Know." Start with *egg, hatch, chicken, bird,* and *parent.*

Find the parent.

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LESSON 2, page 77

SUBCONCEPT: Some animals reproduce their own kind through eggs laid externally.

Aim of the Lesson

Children discover the fact that turtles hatch from soft-shelled eggs; the young are like the reptile parent that produced the eggs.

Introducing the Lesson

SUGGESTED: a small turtle, available from a dime store or pet shop, and a pan of water.

Invite the children to examine the turtle, handling it gently. Let those who have had turtles for pets tell the class about them. Call attention to the turtle's features: legs, head, shell, the way it moves on the ground, and the way it uses its legs to swim. Recall the young chicken emerging from its egg, and lead the class to wonder:

Where does a turtle come from?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to page 77. Call on someone to tell what is shown in the picture at the top of the page. There the children see that a ***turtle***, like a chicken, comes from an egg.

2. Next, choose a child to read the statement in the middle of the page. Ask whether or not the turtle's parent is an animal that lays eggs. Then ask whether all the animals shown are of the same general kind. **Which one is quite different? Does the bird (sea gull) lay eggs?** Most children will know that the bird is an egg-layer. **Could the young turtle hatch from a sea gull's egg? Could any kind of bird be the parent of a turtle?**

To help the children answer the last question, direct their attention to the picture to find out whether or not the egg from which the turtle is emerging looks like a chicken's egg. Guide them to notice that the shell of the turtle does not crack like a chicken's egg. The shell is soft but tough.

Explain that all birds lay hard-shelled eggs. Some kinds of animals, including turtles, lay eggs that have soft shells. Since the young turtle is coming from a soft-shelled egg, its parent cannot be a bird.

Now ask the children to look carefully at the other animals pictured on the page and then to put their fingers on the young turtle's parent.

Call attention to the shells of the turtles, on which ***scales*** can be seen. Introduce the word ***reptile***, and explain that turtles are reptiles. All reptiles have scales. Ask: **Do the remaining animals in the picture (*snake* and *lizard*) have scales? Do you think they are reptiles?** Most reptiles, like turtles, lay eggs which hatch into young of the same kind: turtles from turtle eggs, snakes from snake eggs, lizards from lizard eggs.

Lead children to the following understandings:

A young turtle hatches from a soft-shelled egg.

A young turtle is like its parents.

Turtles are reptiles.

All reptiles have scales.

Extending the Concept

Through Activity. Make a turtle home in a glass or pottery dish that has a flat bottom. A large casserole is good for this purpose. Cover the bottom with a few inches of water and use stones to form islands. To create a natural looking environment, plant clumps of turf or moss near the stones. Use a stone or a piece of wood over two stones to make a shady shelter. Put in one or two small turtles purchased at a dime store or a pet store. For a balanced diet, feed them live worms, moths, slugs, or small snails, and also tiny bits of lettuce, fruit, lean hamburger, canned fish, and, occasionally, a pinch of powdered egg shell. Commercial turtle food may be substituted if the suggested foods cannot be obtained conveniently.

Through Activity. Lizards of various kinds may be kept in the classroom. Make a home for them in an unused aquarium or a terrarium as mentioned in Lesson 8, Unit Five. Provide an area of shade and shelter for the lizard to crawl under, and a small potted plant or a tree branch for climbing. Lizards must be fed live flies, moths, meal worms, etc. The temperature should be kept between 65 to 80 degrees.

Through Investigation. Let children use a magnifying glass to count the main growth rings on one of the scales of a turtle's shell. On most turtles, a new edge forms on each scale every summer. These successive edges form the characteristic "growth rings." Help children to discover how many summers the turtle that they are looking at has lived.

Through Key Concept Words. Add *turtle, snake, lizard, reptile,* and *scales* to the Science Vocabulary Chart.

Find the parent.

LESSON 3, page 78

SUBCONCEPT: Some animals reproduce their own kind through eggs laid externally.

Aim of the Lesson

To fix the concept that like begets like through study of an insect; the new insect is the same kind as the one that laid the egg.

Introducing the Lesson

Lead the children into a discussion of eggs. Through the discussion, review what has been learned about eggs from chickens and turtles or, more generally, from birds and reptiles.

Do any other kinds of animals lay eggs?

Developing the Concept

(by emphasis on the subconcept)

Direct attention to the picture at the top of page 78. Help children to identify the animal as a young ***grasshopper.*** Ask what else they see in the picture. Most children will recognize the small objects as a cluster (or bunch) of eggs. Explain that the tiny animal hatched from one egg is of the kind shown in the picture.

Then call on a child to read the sentence on the page. Ask the class what kind of animal to look for. **What kind of animal is a grasshopper's parent?**

By now, the class knows that parent animals are like their offspring and vice versa, and so a grasshopper will be named as the parent of the young grasshopper (or grasshopper nymph). Have the children point to the picture of the parent grasshopper.

Now ask the children to look carefully at both grasshoppers — the parent and the young — to find out ways in which they are alike and ways in which they are different. Help the class, through discussion and picture study, to make the following observations:

Both grasshoppers have six legs (in pairs).
Both have long feelers.
The parent has (four) wings.
The young grasshopper has no wings.
They are the same kind of animal.

Introduce the word ***insect,*** and explain that grasshoppers are insects. All insects, when they are grown up (or adult), have six legs and two feelers (or antennae). Most grown-up insects also have wings.

Have the class look at the pictures of the grasshoppers and note the insect characteristics. **How many legs do they have? How many feelers? What about wings? Why does only one of the grasshoppers in the pictures have wings?**

Guide children's answers to reveal the fact that the young (or new) grasshopper does not yet have wings. As it becomes older (actually from about age two weeks on), wings will start to grow.

Now direct attention to the other animals shown at the bottom of the page. For each one, ask: **Is this an insect? How can you tell?**

Since all the animals illustrated, except the spider, have six legs, wings, and a pair of feelers, children will enjoy identifying them as insects. The spider, with its eight legs, will be identified as a noninsect — as another kind of animal.

Check the children's understanding of the concept that is basic to this section by concluding the lesson with questions like these:

Where did the eggs come from (top picture)?
Where did the young grasshopper come from?
Which insect is the young grasshopper most like? Why?

Encourage answers that reveal understanding of an insect laying eggs, a young insect hatching from an egg, and the young growing to be like the parent.

Extending the Concept

Through Investigation. To quiet, or at least slow down, an active insect, place it in a jar covered with cheese-cloth and put it on a shelf in the refrigerator until it stops hopping about. Then have children use magnifying glasses to observe the insect's parts: its body, which consists of three different parts; the large eyes; the wings, if any; the feelers, which some insects use for detecting sound, odor, and taste, as well as for feeling.

Through Key Concept Words. Add *insect* and *grasshopper* to the Science Vocabulary Chart.

Through Library Research. On shelf and reading table, make available science picture and story books about insects. Encourage children to browse through the insect books and, if they can, to read the stories.

With Rapid Learners. Help children to discover how grasshoppers (and other insects) breathe.

Find the parent.

78

LESSON 4, page 79

SUBCONCEPT: Some animals pass through a cycle of change from egg to adult.

Aim of the Lesson

To help children relate the concept that like begets like to the life cycle of a moth as it changes from one stage to another.

Introducing the Lesson

SUGGESTED: a caterpillar. (If none is available, use another kind of insect larva such as one in a "wormy" apple.)

Let children take turns looking at the ***caterpillar.*** Through appropriate questioning, have children observe how the animal moves, the kind of skin it has, and (if it is feeding) how it gets food. Explain that the animal is called a *caterpillar;* it is not a *worm.* Children tend to use terms like caterpillar and worm indiscriminately. Lead into the lesson by asking:

What kind of animal is it?
What do the parents of this animal look like?

Developing the Concept

(by emphasis on the subconcept)

1. Have children study the picture at the top of page 79 as you call on volunteers to identify the animal (a caterpillar) and tell what it is doing (feeding on a leaf).

2. Then choose someone to read the sentence on the page. Without further comment, ask the class to study all the pictures on the page and to choose, without telling, the one they believe illustrates the caterpillar's parent.

Ask each child to explain why he has picked the animal he has, but do not tell who is right or wrong.

After all who wish to answer have done so, ask the class to look at the upper picture once more while you tell about the life of a caterpillar. You may wish to follow the suggestions below.

A caterpillar, like many other kinds of animals, is hatched from an egg. (Call on children to tell of other animals that come from eggs.)

While the caterpillar is growing inside its tiny egg, it has plenty of food. **Where do you suppose the caterpillar's food comes from?** (Inside the egg.)

Almost as soon as the caterpillar crawls out of its shell (which is somewhat brittle), it begins to eat leaves. As it eats, it grows bigger and bigger, but its skin does not grow. In about a week or so, the caterpillar's skin splits open, and the animal climbs out of its tight, old skin. Underneath, it has a new skin that is big enough for its body.

The caterpillar does this skin splitting many times, until it is as full-grown and handsome as it looks in the picture. (Call on children to describe the caterpillar in detail.)

It now begins to make a ***cocoon,*** an enclosed "bag," around its body. Inside the cocoon, new parts begin to grow: six long legs; two feelers that look like feathers; and four splendid wings with bands and spots of color. Finally the caterpillar is completely changed; it is a caterpillar no longer. It is a ***moth.***

The moth makes an opening in its cocoon and sticks out its head. It then pulls the rest of its body out. Finally, it uses its wings to lift its body and to fly away.

Later, the moth lays eggs which hatch by themselves. Out of each little egg comes a — **can you guess what?**

Next, ask someone to point to the parent, the moth (*Polyphemus* or American silkworm) that laid the eggs.

Have the children count the legs on the moth and identify it as an insect. **Do any of the other adult animals appear to be insects? Why?**

Summarize the lesson by outlining (orally) the four stages in the life of a moth: *Egg, caterpillar, cocoon,* and *moth.* The stages are repeated when the new moth lays eggs.

Help the class to reach these understandings:

Moths are insects.

They go through (four) different stages as they grow.

The caterpillar will change into an adult moth of the same kind as the one that laid the egg it came from. It will develop into an adult like its parent.

Extending the Concept

Through Activity. If season and local conditions permit, encourage children to capture caterpillars. Each caterpillar may be put into a transparent plastic jar (ice-cream container) with many holes punched in the lid. Some leaves and other parts of the plant on which the caterpillar was found should be placed in the jar. If a caterpillar is given plenty of fresh food, it may spin a cocoon (or simply make a tough case for itself, depending on the kind of caterpillar).

Through Key Concept Words. Add *caterpillar, cocoon,* and *moth* to the Science Vocabulary Chart.

Find the parent.

79

LESSON 5, page 80

SUBCONCEPT: Some animals produce their own kind through eggs laid externally.

Aim of the Lesson

To give children further opportunity to study the relationship of egg to adult in another organism; fish hatching from eggs are the same kind as the fish that laid the eggs.

Introducing the Lesson

SUGGESTED: goldfish (or another kind of egg-laying fish) in a jar or aquarium or pictures of ***fish*** in an aquarium.

Have children go in small groups to look closely at the fish. Encourage a discussion of fish — where they live, how they move, and how they breathe. Review chickens, turtles, grasshoppers, and moths coming from eggs (Lessons 1–4), and lead children to the question:

Where do fish come from?

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: a small jar of salmon eggs. (In many parts of the country these are sold in sporting goods stores for use as fish bait.)

Invite the class to look at page 80. Call on someone to tell what he sees in the picture at the top of the page. Identify the young fish as ***salmon*** that have hatched from the eggs.

If you have some salmon eggs, spread them on a paper plate for the children to examine. Have children touch the salmon eggs to discover that the eggs have soft shells.

Through discussion, review what the children know about eggs: An egg is like a seed. It has a shell or covering, the beginning of a new living thing, and food for its early growth. Some eggs (like chickens') have hard shells. Some eggs (like turtles') have soft shells. Birds, reptiles, and insects lay eggs.

Ask what kind of fish will come from salmon eggs. Then have children point to the parent of the young salmon at the bottom of the page.

Ask where fish (all kinds) live. Through discussion, establish clearly that fish live in water below the surface. They cannot live out of water like the other animals that have been studied.

Even though a fish lives under water, it needs air. **Then, how do fish breathe?** Water in which a fish can live also contains air. Introduce the word ***gills*** and explain that all fish have gills which are able to take some air from the water. The breathing parts of our bodies cannot do this.

Direct attention to the fish in the jar and to the picture of the large salmon. Point to the location of the gill openings. Explain that a fish takes in water through its mouth. The water then goes out through the gills, which remove the air that the fish needs.

Next, have the children look at the other pictures on the page and answer questions such as those suggested here:

Which animals can live in water? Out of water? What kinds of animals are shown? How can you tell?

Through discussion, lead the children to the following understandings:

The young fish (salmon) hatched from eggs.

The eggs were laid by the big salmon.

The young are the same kind as the fish (salmon) that laid the eggs. They are like their parent.

Fish live in water; and take air from the water by means of gills.

Check for understanding by presenting the following statement for discussion:

There is an old saying: "As helpless as a fish out of water." **Are fish helpless when they are not in water? Why?**

Extending the Concept

Through Activity. Let children go to a classroom aquarium in small groups to watch the fish continually moving their mouths to take in water, not to drink, but to get air. A large magnifying glass might be shared to facilitate observation.

Through Key Concept Words. Add *fish, salmon,* and *gills* to the Science Vocabulary Chart.

Through Investigation. Let children discover that there is air in water. Fill a clear glass or jar with water and do not touch it for a half day. Then ask children to notice the tiny bubbles of air clinging to the glass.

Through A Field Trip. If possible, arrange a guided tour through a fish hatchery. If this is not convenient, try to visit a local pet shop, where the children may observe aquariums of tropical fish.

Through Audio-Visual. If films or filmstrips about fish and hatcheries are available and are suitable for this age group, use them to extend the concept.

Find the parent.

LESSON 6, page 81

SUBCONCEPT: Some animals develop through stages before appearing like the parent.

Aim of the Lesson

To help children discover that frogs lay eggs that hatch into tadpoles and the tadpoles develop into frogs.

Introducing the Lesson

Through brief discussion, review what has been learned about gills. Then ask how our bodies take in the air we need. Have children exhale and then inhale, feeling their chest expansion with their hands. Introduce ***lungs*** and explain that we, and many kinds of animals, use lungs for breathing.

Do any animals except fish use gills?

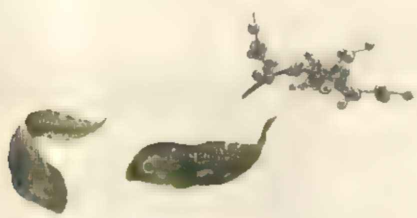
Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the picture at the top of page 81. Call on someone to describe what he sees there. Explain that the things he sees swimming are ***tadpoles,*** commonly called polliwogs. Then ask the children what they think the jellylike mass contains. They will probably recognize the spheres as eggs, from which the tiny tadpoles hatch.

Ask next where tadpoles live and how they breathe. Through discussion, establish the fact that tadpoles live under water and breathe by means of gills, as fish do.

Children who have not had experience with frogs or toads may have difficulty in identifying the parent. So, you may need to tell briefly the life story of tadpoles.



Find the parent.

81

The eggs you see in the picture were laid in a pond near the shore early in spring. Some children collected the eggs in a can and brought them to school. The little eggs stay alive in the aquarium.

In a few days, tiny tadpoles hatch from the eggs and as they grow, look like those shown in the picture. The tadpoles remain under water all the time. **How do you think they breathe?** (Here help children to recall what they have learned about gills.) Tadpoles have gills and the young ones you see look and act much like fish.

After a while, though, the tadpole changes. Four legs grow out from its body. Its eyes get big and bulging. Its tail begins to disappear. It no longer uses gills for breathing. It climbs out of the water and begins to breathe air as we do. Its fishlike days are over. The tadpole has changed into a ***frog.***

2. Now have someone read the sentence on the pupil's page and find the tadpole's parent at the bottom of the page.

Call for volunteers to tell the story of the life of a frog, beginning with the egg.

Through discussion, help the class to summarize what they have found out about the life of frogs:

A frog begins life in an egg.

The egg hatches into a tadpole.

The tadpole has gills. It uses its gills to take air from water.

The tadpole grows and changes into a frog.

The frog has no gills. It breathes through lungs, as we do.

The adult frog lays eggs.

3. Next, have children look at each of the other animals pictured on page 81, while they respond to questions similar to those suggested below:

Could the fish (trout) lay eggs that would hatch into tadpoles? What hatches from fish eggs?

What kind of animal is the dragonfly? Does it lay eggs? Could a tadpole hatch from its eggs?

What hatches from a turtle's egg? What kind of animal is the turtle's parent?

By now, most children will be able to generalize somewhat as follows:

Some kinds of animals lay eggs.

Young animals hatch from the eggs.

The young animals grow to be like the animals that laid the eggs.

Extending the Concept

Through Activity. If the season and location permit, raise some tadpoles in the classroom. Secure eggs from a pond or stream, and collect extra water to provide for replenishment. Collect also some of the green pond scum (algae) on which the young tadpoles can feed.

Through Key Concept Words. Add *tadpole, frog* and *lungs* to the Science Vocabulary Chart. (If the class seems ready for a more extensive vocabulary, you may wish to explain that frogs and toads are *amphibians* and add two new words to the chart.)

UNIT EIGHT: ANIMALS AND MORE ANIMALS

Section 2: New-born Mammals

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 7, pages 82 and 83

SUBCONCEPT: Mammals bear their young alive; they do not lay eggs.

Aim of the Lesson

To extend the concept "like begets like," to farm animals.

Introducing the Lesson

SUGGESTED: a bulletin board display of farms and farm animals.

Introduce the topic of life on a farm in the spring. What kinds of animals are raised on farms? From children's comments, make a list of some of the animals that are raised on farms. Explain that four-legged animals that live mostly out of doors, usually are born in the spring. The young then have warm days in which to grow. Lead to the question:
What are the new-born animals like?

Developing the Concept

(by emphasis on the subconcept)

Invite the class to look at the pictures on page 82. Call on someone to read the words on the page.

1. Choose a child to describe the cow shown at the top of page 82 (color, size, etc.). Call attention to the ***calf***, and call on someone to tell the ways in which it looks like the ***cow***. Then ask *why* the calf looks like the cow. (The cow is the calf's parent. The calf looks like its parent.)

If any of the children have had experience with cattle, encourage them to tell about different coloring and marking, etc.

2. Next, have the children look at the picture of the ***rabbits***. Call on a child to point to the six small rabbits and the rabbits' parent. Count the number of young rabbits. Ask whether a white duck or a white cat could be the parent of the young rabbits. **What kind of animal must be the parent of rabbits?**

Perhaps some children now have, or formerly had, rabbits for pets. If so, invite them to describe the appearance of the young rabbits, how they were cared for, what they were fed, what they felt like when they were touched, how they moved, etc.

3. Call attention to the group of animals shown at the bottom of the page. Choose someone to identify the big animal. (If the word ***sow*** is used for the mother animal, explain it to the rest of the class.) Let the children count the number of baby animals. Ask what kind of animals they are. Through discussion, guide children to make the following observations:

The big animal is a ***pig*** (sow).

The big pig has four little pigs.

The little pigs look like their parent.

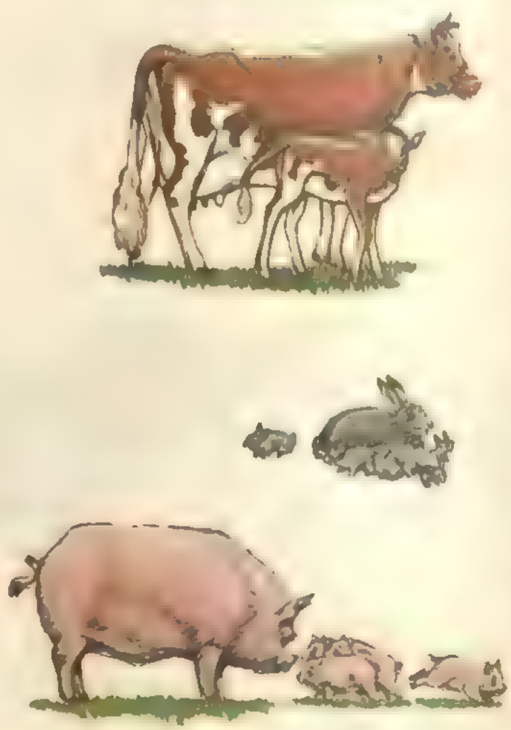
How many legs does a pig have? a cow? a rabbit? Lead the class to recognize that all the animals shown on the page are four-legged animals.

4. Move next to the picture of the ***horse*** at the top of page 83. Call attention to the white spot, called a star, on the forehead of the big horse. You may wish to introduce the term ***colt***. Have the children look carefully at the big horse and at the little one (or colt) to find the ways in which they look alike. Guide them to notice the similarity in color and marking. **Is the big horse the parent of the little one?** Encourage the children to give reasons for their answers.

Now let children who have had experience with horses tell about such things as patting a horse, the feel of its coat, feeding it hay, etc. If children mention pony rides, explain that a pony is a kind of small horse; it doesn't grow much bigger than the colt in the picture. Through discussion of horses and ponies, develop these ideas:

A horse has a colt, which grows to be a big horse like its parent.

A pony has a colt, which grows to be a pony like its parent.



Animals on the farm

82

5. Then have the children study the other two pictures on page 83. Call for volunteers to identify the adult ***sheep*** and ***goat.*** You may wish to identify the ***lamb*** and ***kid*** by name.

Do you think that a sheep could ever be the parent of a young goat? Help children to understand that the sheep must be the parent of the lamb, and the goat must be the parent of the kid.

Through further study and discussion of the pictures on the pupils' pages, develop these understandings:

Farm animals have young (or "babies").

Each young (or "baby") animal is the same kind of animal as its parent.

Now ask the class to tell ways in which all animals shown on these pages are alike. You may need to present questions similar to the ones suggested below:

How many legs does each one have? How do the animals move from place to place? What kind of covering do they have on their bodies? Do any of these animals lay eggs?

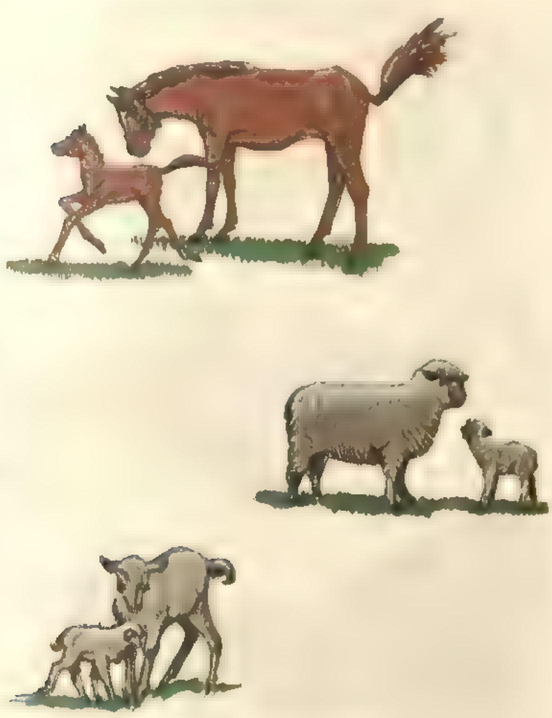
The children's answers will help them to discover that all the animals shown in the pictures are alike in these ways:

They all have four legs, which they use for walking, running, or jumping.

Their bodies are covered with hair or fur.

They do not lay eggs; they have live young (or "babies").

Introduce the term ***mammal,*** and state that all of the animals shown on these two pages are mammals. Mammals do not lay eggs. Their young are born alive. (Two exceptions, the spiny anteater and the duckbill platypus, belong to the lowest order of mammals. They do lay eggs.)



Animals on the farm

83

To evaluate the children's comprehension of mammals, invite them to name some mammals, other than those in the illustrations. Help them to think of four-legged animals with hair on their bodies. As children mention dog, cat, mouse, etc., encourage them to explain why they think that each is a mammal.

You may wish to check to see if the children can distinguish animals that are not mammals by presenting the following:

A turtle has four legs. It walks on its four legs. **Is a turtle's body covered with hair? With a shell? Does a turtle lay eggs? Is a turtle a mammal?**

A chicken is a farm animal. **What covers a chicken's body? Does a chicken have four legs? Two legs and two wings? Does a chicken lay eggs? Is a chicken a mammal?**

Extending the Concept

Through Activity. White rats, available from pet stores or from hospital research laboratories are good mammal pets for the classroom. Obtain a pregnant rat, and house it alone in a wire cage, preferably one with an exercise wheel. A suitable cage may be available in the school, may be loaned by a child, or may be purchased from a pet store.

The rat's gestation period is about three weeks. Near the end of this time, add shredded newspaper to the cage. The rat will make its own nest for its young.

Feed adult rats on dry bread, bread and milk, lettuce, carrots, sunflower seeds. Since rats will also feed on practically anything that we eat, they may be fed table scraps. Include some green sticks covered with bark for gnawing.

Accustom a pet rat to being handled by moving slowly, speaking softly, and holding it firmly without squeezing. The young may be picked up as soon as their eyes are open (at age 16 to 18 days) if handling them does not seem to upset the mother. When the young are about 24 days old, begin to wean them by feeding them milk-soaked bread and bits of lettuce. By the time they are a month old, they may be fed the regular adult diet.

Through Activity. Help children to cut out pictures of animals from old magazines. Let them use the pictures to make an animal scrap book, keeping birds, fish, reptiles, insects, and mammals separate.

Through Key Concept Words. Add *cow, rabbit, pig, horse, sheep, goat,* and *mammal* to the Science Vocabulary Chart. (Optional: add *calf, colt, lamb,* and *kid.* If *sow* is introduced, add it also.)

With Rapid Learners. Ask the children to find out why cows (or cattle) are important to us. **What things do we get from cows?** Encourage pupils to bring in well-washed milk cartons, evaporated milk cans, cheese wrappers, butter cartons, and cottage cheese boxes as containers that once held food that came from cows. Use the children's contributions for a display. "Things We Use From Cows." From cattle we also get meat and leather goods (beef products and cowhide).

LESSON 8, pages 84 and 85

SUBCONCEPT: Mammals bear their young alive; they do not lay eggs.

Aim of the Lesson

To provide experiences by which children may extend their understanding of the concept "like begets like" to include mammals at the zoo (the young are like their parents).

Introducing the Lesson

Lead the class into a discussion of familiar four-legged animals. Through the discussion, review what the children have learned about mammals. As animals on the farm and pets at home are mentioned, present the question:

Where else can we see mammals?

Developing the Concept

(by emphasis on the subconcept)

Direct attention to page 84. Call on someone to read the caption on the page. The idea of a ***zoo*** is to show wild animals that people generally would not see locally. Many of the animals in a zoo are captured in faraway places.

Find out how many children have ever visited a zoo. Invite different children to tell about some animal that seemed most interesting to them when they visited a zoo.

1. Then choose someone to tell what he sees in the first picture on page 84. Explain that the big ***gazelle,*** shown in the picture, had a baby at the zoo. Ask whether the young gazelle looks like the horse or the pig that they saw in the last science lesson. **What grown animal does it look like?**

Call on several children to tell about ways in which the young gazelle is like its parent: its legs, ears, tail, and skin. Explain that the skin of the gazelle is covered with hair.

Does the parent have horns? Does the "baby"?

If any children remember having seen a live gazelle, invite them to tell the class.

2. Next, call on children to identify the ***lion*** and the ***bear*** shown in the other pictures. Ask what their baby animals are like. Through discussion, develop these understandings:

The lion has three young lions.

The bear has two young bears.

The young animals look like their parents.

Have the children look at all the animals on the page and then tell how many legs each one has. Ask whether the animals' bodies are covered with scales, feathers, or hair. Tell the class that the animals are covered with ***fur.*** Bring out the idea that fur is really very thick hair. Lead children to identify the gazelles, lions, and bears as mammals. **Do you think that any of these animals lays eggs? Do they all have live babies?**

3. Then ask the class to study the pictures on page 85. To find out whether they think the animals are mammals, offer suggestions like the following:

Look for any animals that do not have hair or fur on their bodies.

Look for animals that do not have four legs.

Do you find any?

In what ways are the animals shown on this page like those shown on page 84? Explain that the ***kangaroo,*** giraffe, and zebra all have live babies. Are these animals all mammals?

Continue the study of the pictures on page 85. By means of comments and questions similar to the ones suggested below, reinforce the idea that each kind of animal has its own kind of young:

The kangaroo has a baby. **What does the baby look like? What kind of animal is it?**

See what a long neck the ***giraffe*** has! It can reach leaves that grow high on trees. **When the giraffe's baby is grown up, will it be able to do the same? Why do you think so?**

The ***zebra*** looks much like a horse with a striped coat. **Could the zebra have a baby lion like those shown on page 84? Why not?**

To evaluate the success of the lesson, present the following problems:

The mother lion (page 84) eats only meat. The baby lion has only milk for food. **When the young lions are full-grown, what will they eat?**

The zebra (page 85) eats grass and other plants. The baby zebra, like the baby lion, has only milk for food. **When the young zebra is full-grown, will it eat the same kind of food that the full-grown lions eat? Why not?**

The answers will help to demonstrate that the young lions and zebra will grow to be like their respective parents; what the babies eat has no bearing on what the grown animals will eat; the lions will become meat eaters; the full-grown zebra will feed on plants. The same is true of giraffes, gazelles, lions, and bears.

Animals at the zoo

84

Extending the Concept

Through a Field Trip. If it is feasible, take the children to a zoo to see mammals (and other animals) and their young. Find out, by either mail or phone, whether there have been any recent births at the zoo. If so, prepare the children for the particular kind of zoo babies they are going to see. If the zoo is a large one; do not attempt to cover an entire zoo in a single trip. Instead, plan to spend time observing only the animals with young or the animals in a limited area. If children are enthusiastic about the zoo (as they usually are) suggest that they arrange to have someone take them there again on a holiday or weekend.

Through Key Concept Words. Add *fur, zoo, gazelle, lion, bear, kangaroo, giraffe,* and *zebra* to the Science Vocabulary Chart.

Through Library Research. Make available a large number of books containing realistic pictures of animals. Do not hesitate to include preschool picture books as well as books that are beyond first-grade reading level. Give children time to look through the books to discover things about different kinds of animals. (*Suggestion:* Do not include in this selection any of the animal fantasy books — those showing animals in caricature, in costume, or acting like humans. Such books, though interesting and valuable as literature, can interfere with understanding when used as an extension of a science lesson.)

Through Art. Suggest that children who like to draw make pictures of zoo animals and their babies. Use the pictures for a classroom exhibit.

Through a Class Project. Make a "worm farm" in the classroom or outdoors. Fill a glass tank or large jar with topsoil. Moisten the soil and add earthworms, which children can dig from the ground or collect from the surface after a rain. Mix cornmeal or other cereal food into the top layer of soil in the tank or jar. Then cover the glass sides with dark paper or cloth till the earthworms have made themselves at home. Keep the "worm farm" in a cool place, with the soil damp (but never wet). Make certain that there is always some kind of food in the soil.

Animals at the zoo

LESSON 9, pages 86 and 87

SUBCONCEPT: Mammals bear their young alive. The offspring resemble the parents.

Aim of the Lesson

Children come to the realization that their mammal pets have young; that the young are very much like their parents, but not identical.

Introducing the Lesson

REQUIRED: a bulletin board display of snapshots of children's pet dogs and cats. Try to get several from different pupils.

Let children take turns telling the class about pets they have had. Have those who contributed snapshots go to the bulletin board and point to the pictures as they speak of their pets. Discuss puppies and kittens and lead to the question:

Are puppies and kittens like their parents?

Developing the Concept

1. Direct attention to the picture of the boy with his pet ***dog.*** Call on children to describe the dog. To lead the class into a discussion of the needs of an adult dog, mention that this boy takes good care of his dog. Help the children to understand that a dog needs food (meat or prepared dog food): plenty of fresh water; a warm, dry place to sleep; protection from traffic and other dangers. Bring up the matter of breathing and, by questioning, get the children to realize that dogs, like people, breathe air by means of lungs.

(Someone may ask what kind of dog is shown in the picture. The dog is a Dalmatian, though it may be referred to simply as "the boy's spotted dog" or called a "coach dog.")

2. Have children study the picture at the bottom of page 86, and count the number of puppies. Then ask children to point to the ***puppy*** that looks most like its mother and to the one that looks least like its mother.

Ask: **Will all the puppies grow up to be spotted dogs (or Dalmatians)? Will they all look *exactly* alike?** (You may need to call attention to the number, size, and pattern of the spots.)

Through discussion of the answers to the questions, children are helped to reach the following assumptions:

> All of the puppies are spotted dogs; they are the same kind as the mother.
>
> None of the puppies is exactly like the mother. Some are more like the mother than others.
>
> When the puppies are grown up, they will all be the same kind, but they will not look exactly alike.

By now, any child whose pet dog has had puppies will be fairly bursting to tell of the experience. An account of such natural events as the dog's pregnancy, delivery, and nursing of the new-born puppies is accepted without concern by first-grade children.

3. Next, direct attention to the picture of the girl and her pet ***cat*** on page 87. Call on children to describe the cat. **Does it have spots, like the dog? Is it all one color? What color is it?**

While children continue to look at the picture, you may wish to tell them a story something like the one given here.

Jean is a little girl in the first grade. She always wanted a pet, but she never had one. One night when she was ready for bed, she heard a scratching sound at the back door. Then she heard, "Meow, meow, meow!"

When she opened the door, there was a black cat. Jean's mother let her feed the cat some tuna fish and a bowl of milk. The cat ate the food, then made a soft purring sound, and rubbed its furry coat against Jean's legs.

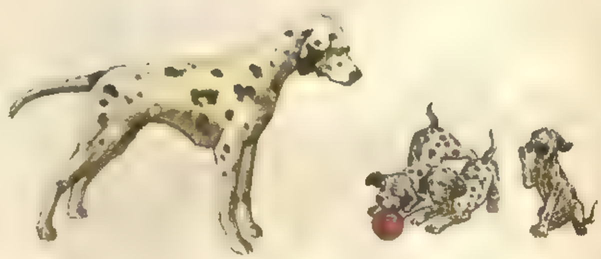
From then on, the cat was Jean's special pet. She named her pet "Blackie." **Do you think that Blackie is a good name for Jean's cat?**

One morning Blackie had a big surprise for Jean. Look at the picture at the bottom of the page to find out what the surprise was.

Call on someone to count the number of ***kittens.* Which kittens look most like Blackie? In what ways are the others different from their mother? Are any of the young animals rabbits or puppies? What are all of Blackie's babies?**

Through study and discussion of the picture, guide children to these assumptions:

> All of the cat's young (or "babies") are kittens. They will all grow up to be cats, the same kind of animal as their parent.
>
> One kitten is all black, just like the mother cat.
>
> Two are black and white; the color of their fur is different from that of the mother cat.



Dog with puppies

Ask different children to tell some things that Jean should do to take care of her pets. Help children to realize that pets need food, water, warmth, protection, and air. (You may wish to discuss how the kittens are fed when they are first born. Also, if white rats or any other mammals have been born and reared in the classroom, have children compare the actions of the kittens with those of the animals the class has observed.)

To evaluate the children's comprehension of the concept of like producing like, present a situation such as the following for discussion:

Frank was just a little boy when his cat had kittens. He had been hoping for a dog, and so he asked his mother to give dog food to one of the kittens. "If the kitten eats dog food, it will grow up to be a dog," said Frank. **Do you agree with Frank?** Explain your answer.

By now everyone will understand that kittens always grow up to be cats; they are cats because their parents were cats. Nothing can change an animal from one kind to another.

Extending the Concept

Through Activity. Collect some live garden or woodland snails and make a home for them in a Mason jar in which the metal disk sealer has been replaced by a piece of wire screening. Place a layer of damp soil in the bottom of the jar. Stick the stems of a few sturdy fresh plants or leafy twigs into the soil. Replace them as they become wilted or are shredded by the snails' feeding. Keep the "snail house" in a cool, shady spot, and let the children experiment with various kinds of food: lettuce and other kinds of leaves, flower petals, dead insects, bits of bread and meat, etc. Encourage children to use magnifying glasses to observe a snail sliding along on its flat, moist *foot*, using its rasplike tongue to shred green leaves, moving its head, extending its two tall eye-stalks, and then withdrawing into its shell for protection. Children will observe that snails are different from any of the other kinds of animals they have been studying. (Snails are mollusks, animals without backbones, whose soft bodies are protected by hard shells that grow on the outside. Oysters, clams, scallops, etc., are also mollusks.)

Through Key Concept Words. Add *dog, puppy, cat,* and *kitten* to the Science Vocabulary Chart.

With Rapid Learners. If the children have become interested in snails, tell them about some of the water animals that also have shells. Begin a shell collection, if possible, and help children to classify the shells as univalve and bivalve. Univalves are animals that have one-piece shells: many kinds of snails, and also limpets, conches, and abalones. Bivalves are animals that have two-piece, or hinged shells: mussels, clams, oysters, scallops, cockles, and many others. As children examine and sort out their shells, help them to realize that the shells grew on living animals.

Cat with kittens

UNIT EIGHT: ANIMALS AND MORE ANIMALS

Section 3: Application of Concept of Like Begetting Like

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 10, pages 88 and 89

SUBCONCEPT: Some animals produce their own kind through eggs laid externally.

Aim of the Lesson

To introduce children to some typical American wild birds as a way of exploring further the relationship between organisms and their young; to show them that each kind of bird lays its own kind of egg.

Introducing the Lesson

SUGGESTED: a hen's egg (hard boiled to prevent mess from breakage).

Present the egg and ask what kind of animal it came from. Lead the class into a discussion of chickens and the young chicks that hatch from their eggs. Through the discussion, help children to recall that chickens are birds. Lead children to wonder:

Do all birds lay eggs?

Developing the Concept

(by emphasis on the subconcept)

(Depending on children's interest, attention and participation, you may find it advisable to extend this lesson over two science periods.)

Have children look at the pictures on pages 88 and 89. Give them plenty of time to enjoy the pictures and to identify any of the birds that they may recongize. Explain that each kind of bird is shown with its own kind of egg.

Then help children to become acquainted with all of the birds shown on the pages by presenting pertinent information about each kind. You may wish to follow the storytelling procedure as suggested below:

Blue Jay. Look for a bird that is blue and that has a crest of feathers sticking up from the top of its head. Put your fingers under the words that say ***blue jay.*** (Write *blue jay* on the board.)

A blue jay is the largest bird shown on these pages. It is nearly a foot long (as long as a ruler) counting its tail. There are, of course, many larger birds. **Can you think of some larger birds?** (Turkey, hawk, duck, chicken, eagle, etc.)

If you have ever watched blue jays, you know that they are noisy, bold, and colorful. They fly around yards and near doorways, looking for pieces of bread and other food. Then they swoop down to grab the food with their bills and fly away.

Blue jays feed on insects, on acorns and other nuts, and on many kinds of food they pick up in yards and playgrounds. They also have been known to destroy eggs in the nests of smaller birds.

Most blue jays have crests, which they can raise or lower. (The California jay, common west of the Rockies, has no crest.)

The blue jay lays three to six eggs. **What color is the blue jay's egg? What kind of birds hatch from these eggs?**

The blue jays shown in the picture are "father" and "mother" birds. **Do they look alike? Do you think the birds that hatch from the eggs will look like both parents?**

Oriole. Find a kind of bird that is bright orange and black. With it is a bird that is brown and yellow with some white. This is a pair of birds called ***orioles.*** (Write *oriole* on the board and have the children repeat the word.) Have the children point to the word oriole.

As you can see in the picture, orioles have beautiful feathers, particularly the "father" oriole. These birds make delightful sounds — whistling sounds that are very much like music.

Orioles fly to warm places for the winter and then fly back to cooler places in the spring. They feed on insects, especially on caterpillars that are harmful to plants. Because orioles use insect pests for food, they are quite useful as well as beautiful.

The oriole lays four to six dull white eggs that are marked with streaks of brown and gray. Point to such an egg in the

picture. **What kinds of birds hatch from these eggs? Do you think all the young birds will be orange and black? Will some be brown and yellow? Why?**

Sparrow. Can you find two sparrows on the page? Look for the word, ***sparrow.*** Say the word. Have children point to it. Write *sparrow* on the board.

The sparrows shown in the picture are sometimes called *house sparrows* because they live near homes, in cities, on farms, and on ranches. Sparrows are around us all year long, even in the coldest months of the winter. **Do the two sparrows look much alike?**

Sparrows have strong, thick bills with which they crack the seeds that they use for food. They also feed on many other things, picking up almost any kind of food that happens to be around.

Sparrows are very busy, noisy birds, but not as noisy as blue jays. Perhaps you have heard sparrows chirping around your house.

A sparrow lays four to nine eggs at a time. The eggs are white with yellowish-green, brown, or black spots. **Does the egg in the picture have such spots?** Sparrows generally lay eggs three or four times a year.

What kind of birds hatch from these eggs? Will the young sparrows look like both those shown?

Robin. Now look for a pair of robins. Find the word, ***robin,*** under the picture. (Write *robin* on the board.) You always know a robin by its brick-red breast. Robins are sometimes called "robin redbreasts." **Do the two robins look much alike?**

Robins live in open places, often in back yards and in meadows. They seem to like being near people. Have you ever seen robins in the trees or on the lawn? Have you ever heard a robin sing its lovely song? The robin seems to be singing, "Cheerily, cheerily, cheerily" over and over again.

Robins feed on fruits from trees and bushes. They also catch insects and worms with their sharp, yellow bills. When the weather becomes cold, robins move to a warmer place.

A robin lays three to six blue eggs. Point to a robin's egg. Like sparrows, robins lay eggs several times a year — plenty of robins' eggs to hatch into many young birds. **What kind of birds hatch from these eggs? Will the new robins all grow up with red breasts?**

Mockingbird. The mockingbird is about as long as a robin but more slender and has a longer tail. Its back is gray, and its under side is white. **Can you find the picture of a pair of *mockingbirds?*** (Write *mockingbird* on the board.) **Do both birds look alike?**

The mockingbird is a bird that mocks, or imitates, the songs of many other birds. It sings and sings its many songs. It sings from early morning, before daylight, till late in the evening.

Mockingbirds feed on insects, seeds, and fruits.

A mockingbird lays from four to six eggs. Look at the mockingbird's egg. **What kind of bird will hatch from it? Will all the young birds grow up to look alike?**

Gold finch. Look now for a small yellow bird with black forehead, wings, and tail. This is a "father" ***gold finch.*** Beside it is the "mother" gold finch, olive green and pale yellow. Find the name of these birds. (Write *gold finch* on the board, and have children repeat it.)

The "father" gold finch, as you can see, has bright colored feathers. The "mother" is rather dull beside her gay yellow mate. This is true with many kinds of birds (the peacock and peahen are excellent examples).

Gold finches, which live in most parts of our country, are sometimes called "wild canaries" because of their coloring and their clear and beautiful songs. (Although the canary also is a finch, it is not native to our country.)

Gold finches, like sparrows, have short, strong, thick bills with which they crack open the seeds they use for food.

A gold finch lays three to six eggs. Find the picture of the gold finch egg. **What is the color of the egg? What kind of bird will hatch from this egg?**

Conclude the study of pages 88 and 89 by giving children time to review the pictures, identifying each kind of bird and noting the general size and coloring of the egg laid by each kind. (It may be advisable to mix up the order, as shown: sparrow, gold finch, blue jay, mockingbird, oriole, robin.)

Announce that during the next science lesson the children will have a chance to find out how many *kinds of eggs* they remember.

Extending the Concept

Through Key Concept Words. Add *blue jay, oriole, sparrow, robin, mockingbird,* and *gold finch* to the Science Vocabulary Chart.

Through Activity. On a post or other place sufficiently elevated to afford protection from dogs and cats, put out a shallow pottery dish to serve as a birdbath (or secure a regular cement or plastic birdbath).

Through Activity. Place a shallow wood tray on an outside window ledge, and use it as a bird feeding tray. Encourage children to keep it stocked with food: dried bread, cereals, nuts, and wild bird seed (available at large markets).

LESSON 11, page 90

SUBCONCEPT: Eggs have identifiable characteristics which can be related to the animal that produced them.

Aim of the Lesson

To give children the opportunity to apply their understanding that animals reproduce their own kind to birds and their eggs.

Introducing the Lesson

Use the pictures on pages 88 and 89 as the basis for a review of different kinds of birds. Help children to observe some of the ways in which birds differ (color, size, tails, etc.). Then direct attention to the eggs and lead to the question: **Are only the shells different, or are the eggs different in other ways, too?**

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: a hen's egg.

Have the children look at page 90, and choose someone to tell what he sees on the page.

Ask children to tell whether any of the eggs shown on the page could be chickens' eggs. (If you have a hen's egg, present it as a basis for comparison. If not, have the children recall the size and appearance of chicken eggs from previous experiences.)

As soon as the children are aware that none of the eggs in the illustrations appears to be like a chicken egg, ask where the eggs came from. Guide them to the realization that these are the same kinds of eggs they saw on the two preceding pages. The eggs were laid by the birds shown on those pages. Explain that, on this page each egg is shown in its true size.

1. Now have children look at **Egg 1** (sparrow). Ask what kind of bird laid the egg. If children do not remember that this is a sparrow's egg, ask them to turn back to page 88 and 89 to find out. Then ask whether a blue jay or a gold finch could hatch from this egg. Guide children to reason that only a sparrow can hatch from an egg that was laid by a sparrow.

2. Continue with the other eggs on the page, using comments and questions similar to those suggested below.

Egg 2 (gold finch). **What kind of bird will hatch from Egg 2?** You can find a picture of its parents on pages 88 or 89. Tell us something you remember about gold finches. **After the egg hatches, and the young bird grows up, what will it look like? Why?**

Egg 3 (robin). **Who can tell the kind of bird that laid this blue egg?** (If necessary, give a hint by saying that the bird has a red breast.) **When the egg hatches, what will the new bird be like? Why will a robin, and not some other kind of bird, come from the blue egg?**

For each of the remaining eggs (4, blue jay; 5, oriole; 6, mockingbird), ask children what kind of bird laid the egg and what kind of bird will hatch from it. Encourage children to turn to pages 88 and 89 if they have difficulty in answering and also to verify their answers.

Invite children to tell of other kinds of birds they may have seen.

Through discussion, lead children to the following generalizations:

There are many different kinds of birds.

All birds lay eggs.

Each kind of bird lays its own kind of egg.

An egg hatches into the kind of bird that laid the egg.

Birds and all other animals are like their parents.

Evaluate the success of the lesson by presenting for discussion a problem such as the following:

Stan lives on a farm. He had a hen keeping four of its eggs warm in order to hatch them. Stan wanted to have six baby chicks, and so he bought two eggs from a farmer and put them into the hen's nest. All six eggs hatched, but two of the "babies" were ducks. **Why were there four baby chicks and two baby ducks?**

Encourage children to explain that Stan must have bought two duck eggs, that young chickens cannot hatch from duck eggs. Chicks come from chicken eggs and ducks from duck eggs.

Extending the Concept

Through Library Research. Have a collection of bird books available for browsing. Encourage children to look for both familiar and strange birds.

Through a Field Trip. Take the class for a short "bird walk" around the neighborhood. Try to identify any birds you see.

Through Picture Displays. Collect pictures of birds (other than the ones shown in the child's text) to display on a bulletin board. If possible, include pictures of the eggs associated with each bird.

What kinds of birds will hatch?

LESSON 12, page 91

SUBCONCEPT: Offspring resemble their parents through heredity.

Aim of the Lesson

Children read and discover that each kind of bird builds its own kind of nest.

Introducing the Lesson

SUGGESTED: a bird's nest that has been abandoned.

Present the word ***nest,*** orally and on the board. Call on children to tell what they know about nests. If you have any nests in the classroom, have the children come forward to examine them. Then lead the group into a discussion of what nests are made of and encourage children to wonder:

Are all nests made of the same kinds of things? Are all nests alike?

Developing the Concept

(by emphasis on the subconcept)

Invite children to study the pictures on page 91. Call on individuals to identify the four kinds of birds' nests. Encourage each one to read the names below a picture and then tell something he or she remembers about the bird that made the nest.

1. Now ask everyone to look at the gold finch nest (top right.) Ask what the nest is shaped like. Children will see that the nest is like a cup or small bowl. Explain that it is made of materials from plants — thin strips of bark, dry grasses, and shredded leaves. It has a soft lining of thistle down or other plant fluff. Gold finches make such neat, tightly woven nests that many of them will actually hold water!

2. Next, have the children find the blue jay's nest. Through appropriate questioning, help them to compare the jay's large, loose, untidy nest with the neat, compact one of the gold finch. Help children to see a relationship between the size of bird and its eggs and the size of nest it needs. **Could a blue jay lay three eggs in a gold finch nest?**

Through discussion, help to develop the idea that nest-building, like egg-laying, is part of the nature of the kinds of birds shown on pages 88 and 89.

3. Now direct attention to the nest in the left center portion of the page. Ask someone to tell what this nest looks like and what kind of bird made it. You may need to explain that part of the nest is shown "cut away."

The children will see that the oriole's nest resembles a long bag or purse. They may even be able to detect that the nest is made of plant materials. Explain that orioles, like other birds that live around people, also use such things as bits of string, hair, and soft "man-made materials," such as tissue paper, to weave into their nests.

4. Ask pupils to find the sparrow's nest. Call attention to how well built the nest seems to be and to the plant materials (grasses, twigs, etc.) of which it is made. Sparrows sometimes build their nests on the ground, in tufts of grass, or in bushes or low trees. Sparrow nests are usually not very far above the ground. Ask how many eggs the mother sparrow laid in the nest in the picture. **What will hatch from the eggs?**

Through discussion and study of the pictures, guide the class to these understandings:

There are many different kinds of nests.

There are many different kinds of birds.

Each kind of bird builds its own kind of nest.

Conclude the lesson by leading the class into a general discussion of nests. **What do birds use their nests for?** Help children to understand that a nest is not a bird's "home." Nests are built and used to hold the eggs and also the young birds that hatch from the eggs. After the young birds have flown away, the nest is deserted.

Extending the Concept

Through Investigation. Secure an abandoned bird's nest and let the children work in small groups taking it apart. Provide shallow boxes for the various kinds of materials that comprise the nest: plant materials (leaves, twigs, bark, grasses, etc.); fur or hair; dried mud or clay; and various "man-made" substances (string, paper, cloth, etc.). Encourage children to use a magnifying glass to examine the materials from which the nest was made. Help them to understand that birds build nests from materials that are found nearby. If possible, help the children to count the separate pieces to determine how many trips the bird made while gathering material for the nest.

After the nest has been taken apart completely, let children take turns trying to put it together again. They will soon discover that a bird can make a better nest than they can.

Through Key Concept Words. Add *nest* to the Science Vocabulary Chart.

Through a Field Trip. Conduct, if the terrain permits, a short field trip to find and observe bird's nests.

What kinds of birds will hatch?

91

LESSON 13, page 92

SUBCONCEPT: Offspring resemble their parents through heredity.

Aim of the Lesson

To emphasize the concept "like begets like" through the understanding of parental care for the young.

Introducing the Lesson

Have children open their textbooks to page 89 and find the pictures of the robin and its egg. Through discussion, review the fact that robins (like other birds the class has been studying) lay their eggs in nests; and that young robins hatch from the eggs. Then present the question:

What are young robins like and how are they cared for until they are old enough to fly?

Developing the Concept

(by emphasis on the subconcept)

Choose someone to read the title of the story. Then have the children count the number of young robins in the nest.

1. Call on a child to read the first line of the story: "Four young robins are in the nest." Ask how the young robins got into the nest. Through discussion, bring out these ideas:

The female (or mother) robin laid four blue eggs in the nest.

The female robin kept the eggs warm by sitting on them in the nest. The male (or father) robin guarded the nest.

The young robins were helpless and could only hold up their open mouths for food.

2. Now have someone read the second line: "They are very hungry." Refer the children to the picture and ask how they can tell that the young robins are hungry. **Are they getting anything to eat?**

3. Choose a child to read the third line: "The mother robin feeds them." Refer to the picture, and ask what the young robins are being fed. The children will recognize the caterpillar that is being offered to the young robins. Tell the class that young robins are also fed earthworms, beetles, and other kinds of insects, and various berries.

Ask: **What is the father robin doing while the mother robin is feeding the young?** Help the class to understand that the male is watching over the nest, ready to protect it and to warn the mother robin in case of danger.

4. Have a child read the next line: "The father feeds them, too." Explain that this is not true of every kind of bird. Robin parents, however, take turns feeding and guarding their young.

5. Choose someone to read the fifth line: "The young robins eat and grow." Explain that the young robins have been eating and growing ever since they were blind, helpless babies just hatched from their eggs. Baby robins are great eaters, and they grow fast. The ones shown in the picture are now nine days old. Their parents are kept busy bringing food from morning till night. Ask children to tell ways in which robin parents may care for their young.

6. What will happen as the young robins grow larger and stronger? From personal experience, many children know that the young eventually leave the nest. Call on a volunteer to read the last sentence: "Soon they will fly."

Ask what the young robins must be able to do in order to leave the nest safely. Children will reason that they must be able to fly. Soon after they are able to fly, they also begin to find their own food and care for themselves.

Now have a pupil (or six different pupils) reread the story of "Robins in the Nest." Through discussion of the story and picture, establish these understandings:

Young robins hatch from eggs that are laid by the female (or mother) robin.

Robin parents take turns feeding the young and guarding the nest.

When the young robins are old enough, they fly away.

Young robins grow into adults that are like their parents.

Extending the Concept

Through Activity. If it is nest-building time in your area, have the children collect materials that birds can use: short lengths of yarn and string, cotton, shreds of cloth, dry grasses, strips of facial tissue, feathers, etc. Put the materials in a basket or a box suspended by a rope handle. If possible, hang the basket from a tree in or near the school yard. Otherwise place the basket on a window ledge or suspend it outside. Children can observe the birds pulling out bits of materials to use in their nests, or they can observe the dwindling supply.

Through Activity. If robins abound in the school neighborhood, encourage the children to watch for them and to report to the class about any they have seen.

Robins

Four young robins are in the nest.

They are very hungry.

The mother robin feeds them.

The father feeds them, too.

The young robins eat and grow.

Soon they will fly.

LESSON 14, page 93

SUBCONCEPT: Offspring resemble the parents through heredity.

Aim of the Lesson

To introduce an extraordinary relationship in order to emphasize the concept "like begets like" regardless of the unusual way of providing for the young.

Introducing the Lesson

Draw upon children's experience with birds, eggs, and the young that hatch from them to develop a discussion of the care of newly laid eggs and young birds. Introduce such topics as the need for keeping eggs warm until they hatch, and the young birds' almost continuous need for food. Pose the question:

Do all birds make nests, sit on eggs, and feed their young?

Developing the Concept

(by emphasis on the subconcept)

Have children study the picture on page 93. Call on individuals to describe the nest and to count the number of young birds. Ask whether all of the young birds look alike. Help children to notice that there are two large baby birds and two small baby birds. Explain that there is a difference in size because there are two *kinds* of young birds in the nest.

Identify the nest as a warbler's nest and the yellowish adult bird as a ***warbler.*** The small young birds are baby warblers. Ask what kind of eggs they hatched from.

Cowbirds

A cowbird does not make a nest.

It lays eggs in other birds' nests.

A cowbird laid eggs in a warbler's nest.

A warbler also laid eggs in the nest.

The warbler sat on all the eggs.

The warbler feeds all the young birds.

The young cowbirds grab most of the food.

They may push the warblers out of the nest.

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Introduce the word ***cowbird,*** and explain that the large young birds are baby cowbirds. Ask what kind of eggs they hatched from. Ask: **How did baby cowbirds get into a warbler's nest?**

Encourage the children to speculate as to how this may have happened.

Then tell the class that the story under the picture explains how the cowbirds got into the nest.

1. Call on someone to read the first sentence: "A cowbird does not make a nest." Help children to recall that other birds build nests to hold and protect eggs and young birds.

2. Have everyone read the second sentence: "It lays its eggs in other birds' nests." Explain that the cowbird laid two eggs in another bird's nest.

3. Now have the class read the third sentence, "A cowbird laid eggs in a warbler's nest." A warbler built the kind of nest in the picture — the nest in which the cowbird laid its eggs.

4. Choose a child to read the fourth sentence: "A warbler also laid eggs in the nest."

Explain that once the cowbird had laid its eggs, it flew away and did not return to the nest. Then, pose the questions:

How were the cowbird's eggs kept warm? How were they cared for till they hatched?

5. For the answer, have a pupil read the fifth sentence, "The warbler sat on all the eggs." **How many eggs did the warbler sit on?** Reread the sentence for the class, emphasizing the word *all.*

Call on someone to tell what kinds of birds hatched from the four eggs.

6. Choose a child to read the sixth sentence, "The warbler feeds all the young birds." Tell what word explains which birds are being fed.

7. Have children study the picture to see whether it looks as though all of the young birds are taking turns at the food. Then help a child to read the seventh sentence, "The young cowbirds grab most of the food."

Through discussion, develop the idea that the little warblers are pushed aside by the larger cowbirds. The cowbirds continue to get more and more food and they grow much faster than the young warblers.

8. Finally, choose a child to read the last sentence, "They may push the warblers out of the nest." **If this happened in every warbler's nest, would we have any more warblers?** (We are fortunate that the cowbird is the only native bird that lays its eggs in the nests of other birds and lets other birds hatch and feed its young.)

Through a discussion of robins and cowbirds, and a further study of the pictures on pages 92 and 93, guide the class to these understandings:

Cowbirds lay their eggs in the nests of other birds. They do not take care of their eggs or their young.

Other birds, in whose nests the eggs are laid, care for the cowbird eggs and young.

No matter what kind of bird cares for the eggs and feeds the young, cowbirds come from cowbird eggs.

Extending the Concept

Through Key Concept Words. Add *warbler* and *cowbird* to the Science Vocabulary Chart.

Section 4: Summary and Evaluation

CONCEPT SUMMARY
Organisms (living things) reproduce their own kind.

LESSON 15, page 94

Aim of the Lesson

To give children an opportunity to apply to new situations their understanding of animals reproducing their own kind.

A New View of the Concept

Review different kinds of animals by playing a game. Write *bird, fish, reptile, mammal,* and *insect* on the board. Have the children repeat the words as you point to them. Begin the game by saying, "I'm thinking of an animal that has four legs and fur on its body. What kind is it?" Call on some child for an answer. If he answers, "mammal," then he continues the game. (Another version may be played by using classes rather than characteristics, thus: "I'm thinking of a grasshopper. What kind of animal is a grasshopper?")

Fixing the Concept

Choose someone to read the title on page 94. Then allow time for everyone to look at the six pictures (in circles) on the top part of the page.

Call on a child to tell what is shown in *all* of the pictures. The children will see that all the pictures are of animals, even though the names of some of the animals may be unfamiliar.

Explain that when you call out the number of a picture, children who know the name of the animal in that picture should raise hands. (You may find it necessary to name some of the animals.) Call on individuals to tell about the animal.

You may wish to ask questions about the animal shown.

Below are some types of comments and questions suggested for use with the pictures:

1. (*cricket*) **This is a cricket. How many legs does it have? How many feelers does it have? What kind of animal is a cricket? Why do you say that a cricket is an insect? How many legs did the cricket's parents have? Why do you think so?**

2. (*snake*) **What do you see in this picture? How many legs does the snake have? How many legs did its parent have? What else can you tell us about the snake's parent? Look at the scales on the snake's skin. What kinds of animals have scales on their skin? What kind of skin did the snake's parent have?**

Use questions similar to those for 1 and 2 for the other animals (*mouse, spider, canary,* and *goldfish*).

Now have children look at the three pictures at the bottom of the page. Call on individuals to describe what is shown in each picture. Then ask the class to tell in what ways the pictures are alike. Children will see that each picture shows some kind of animal with its eggs.

Help the children to identify the animals:

butterfly   frog   cardinal

Then present two questions:

a. **Which eggs need to be kept warm if they are to hatch?** (Cardinal's.)

b. **Which eggs do not need to be kept warm?** (Frog's and butterfly's.)

Encourage children to give reasons for their answers.

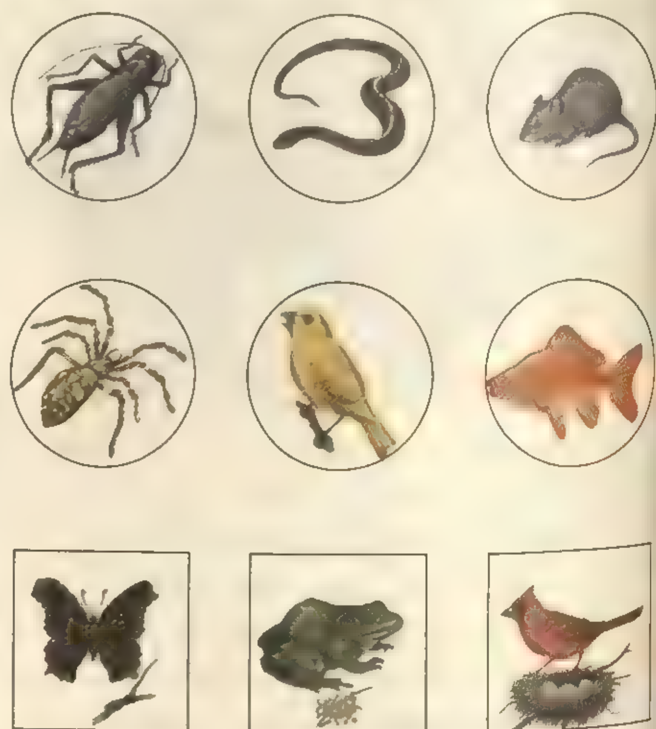
Conclude the lesson, and Unit Eight, by giving time to look back over pages 75-95, and to discuss questions that may be asked.

Extending the Concept

Through Activity. Make an "Animal ABC Book" for use as an independent reading activity. Use words from the *Through Key Concept Words* items of Unit Eight. First copy the words on strips of paper, and arrange them alphabetically.

Use an 18-inch by 24-inch sheet of paper for each of the nineteen letters that begin the words. Put the letter on the top left of the page. Beside it, print the words beginning with that letter. On the remainder of the page, paste illustrations made by or cut out by the children. Children will enjoy searching for appropriate animal pictures to use on the pages.

THE BIG IDEA



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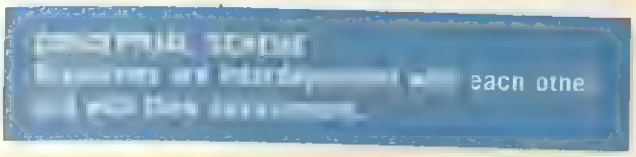
UNIT NINE: LIVING THINGS GROW



Children know that young animals eat and grow larger. They also know that animals stop growing after awhile, when they have "grown up." But what a difference there is in the grown-up sizes of the various animals with which children are familiar! Why, they may wonder, cannot a mouse continue to grow until it is as big as a rabbit, a horse, or an elephant? Or can it?

The first adjectives used by many children are "little" and "big." Perhaps it is children's awareness of their own littleness among so many big people and bigger objects that gives importance to these two words.

Plants, too, come in a wide variety of sizes. One tiny seedling may grow into a clover plant in the lawn; another seedling may become a bush or a giant oak tree.

The Conceptual Scheme is that organisms are interdependent with each other and with their environment. The major concept in Unit Nine is that there is an interchange of matter between living things and their environment.

Matter and Energy from the Environment. Before a seed can sprout, it must absorb water, which it receives from the environment. Water is essential for plants at all stages of development.

Plants also depend on air, or more specifically, on carbon dioxide, one of the odorless, tasteless, invisible gases that make up the air.

Water and air are two different kinds of matter that are essential for the growth of all green plants. From water and air come the raw materials from which green plants make food.

Where the environment does not provide air and water, plant life, at least plant life as we know it, cannot exist. The dry, airless surface of the Moon, for instance, could not support our sort of plant life. A desert environment supports relatively few plants, and, of course, few animals. In this unit the emphasis is on matter relationships.

Like plants, animals use water and air (specifically oxygen) from the environment. Unlike plants, animals cannot manufacture their own food. For this they are dependent on plants or on other animals that are dependent on plants. Hence, an environment without plants cannot support animal life. Food for every species of animal may be traced to green plants, the ultimate source of all food; and food production in green plants can be traced to light energy from the Sun.

Food releases energy for growth and repair when it is oxidized in the bodies of animals. In order to oxidize food, animals must use oxygen, another of the invisible, tasteless, odorless gases in air. Animals will perish in environments that do not provide sufficient quantities of food, water, and air.

Plants and Animals Together. While the principle of interdependence between plants and animals is not dealt with directly in the first grade, it is anticipated by presenting evidence that fish grow better in an aquarium that contains plants than in one without plants. This interrelationship exists, not only in an aquarium, but among all the animals and plants on the earth. Animals take in and use oxygen and give out carbon dioxide, whereas plants take in and use carbon dioxide and give out oxygen.

Heredity and Environment. Plants and animals depend on matter and energy from the environment for their growth, but the environment (even when it is most favorable) does not determine the ultimate *possible* limit of the growth of a plant or animal.

Plants and animals reproduce their own kind (see Units Seven and Eight). The *kind,* with its specific characteristics of size, color, behavior, etc., is determined by heredity. A baby robin, no matter how much food it has, cannot become an eagle; nor can it become as large as an eagle. A young frog may live in a most favorable environment, one that supplies in abundance everything needed for the frog's growth. The frog may grow and flourish, becoming bigger and bigger, until it is a very big frog. It can never, however, become as big as a horse. Heredity establishes general limits in sizes; a mouse cannot grow to the size of an elephant, nor can an elephant be as small as a mouse.

UNIT NINE: LIVING THINGS GROW

Section 1: Plants in Good and Poor Environment

CONCEPT
There is an interchange of matter and energy between living things and their environment.

LESSON 1, pages 96 and 97

SUBCONCEPT: Water is essential to the survival of living things.

Aim of the Lesson

To give children an opportunity to discover the importance of water in the survival of living things (emphasis on plants).

Introducing the Lesson

REQUIRED: some dry seeds of various kinds. For variety, use the flat seeds of summer squash; the small, rough seeds of red beets; the shiny black seeds of wax beans; the crinkly seeds of nasturtiums; and some smooth lima bean seeds.

Let the children handle the seeds and examine them through magnifying glasses. Through discussion, recall (from Unit Seven) that a seed contains the beginning of a new plant. Help children to identify the kinds of seeds. Ask what kind of plant will grow from each different kind of seed. Then suggest the question:

When a seed is planted, what causes it to sprout and grow into a new plant?

Developing the Concept
(by emphasis on the subconcept)

REQUIRED: some dry soil (earth), a coarse kitchen strainer, or piece of wire-mesh screening, two paper drinking cups marked *A* and *B*, six lima bean seeds, a medicine dropper, a basin or bowl of water, and a tablespoon.

Direct attention to the strip across the top of page 96. Call on someone to read "Investigation" and on someone else to describe the materials that will be used in the investigation.

Have the children study the pictures on pages 96 and 97 to find out how many different things they are going to do. They will see that four main steps are illustrated:

1. Sifting the soil to make it fine.
2. Filling the two cups with sifted soil.
3. Planting three bean seeds in each cup.
4. Adding water to each cup.

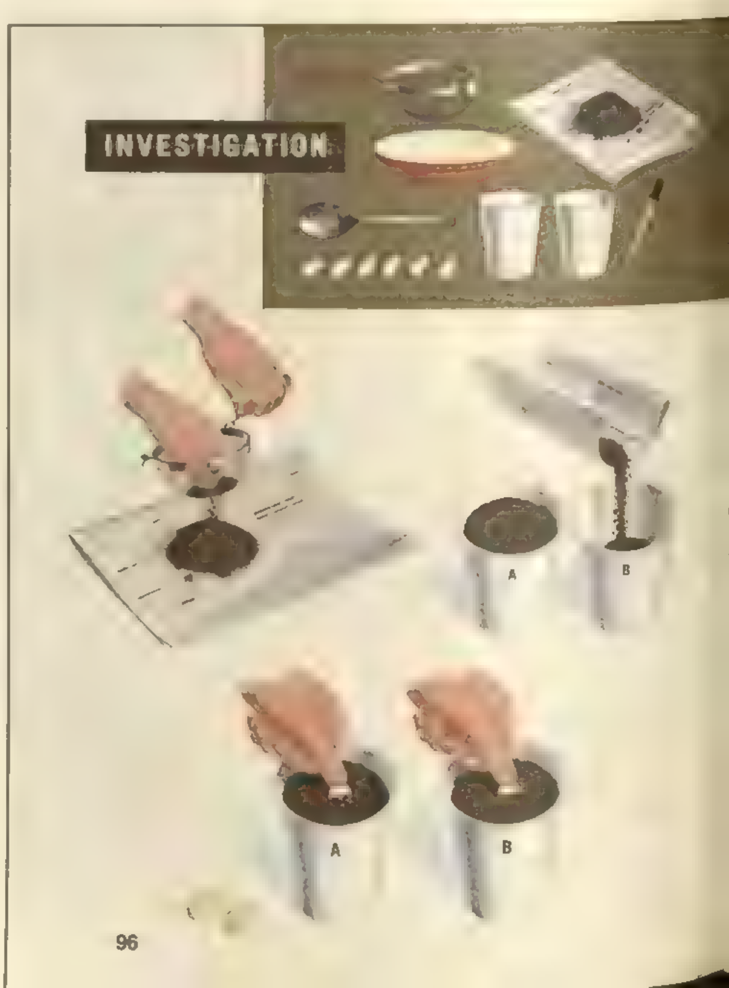
1. To help children realize that an investigation generally has several different steps that must be done in a prescribed order, ask what should be done first. Pupils will see that they must begin with Step 1, shown in picture 1.

Next, find out whether anyone can explain the reason for sifting the soil. **Why do we want fine soil for our cups?** If no satisfactory answer is given, explain that we do not want any pieces of rock or big, hard lumps of soil in the cups. The roots of young plants can grow best when the soil is loose and fine. Also the water is distributed more evenly. (If your school is in an agricultural area, you may wish to compare the sifting of soil for the cups with the plowing and harrowing done on a farm.) Let several children take turns holding the strainer and sifting soil onto a square of paper.

2. When a small mound of soil has been sifted onto the paper, ask the class to look in the textbook to find out what to do next. **What is Step 2 of the investigation?** Looking at picture 2, children will see that the sifted soil is to be poured into the cups. Choose two children to do this. If necessary, help them to make sure that each cup is about three-fourths full of soil.

3. Next, guide the class back to the textbook to find out what is to be done in Step 3. The children will see that in the third picture the bean seeds are being planted.

Have a child come forward and count the seeds. Explain that we want to plant the same number of seeds in each cup. Call on a volunteer to show how many bean seeds there are for each cup. To reinforce the fact that six seeds may be divided into two sets or groups of three seeds each, have the child count seeds, moving them as he counts until he arranges two equal sets of three seeds. Have him place three seeds beside cup *A* and three beside cup *B*.



Then choose different children to do the planting. Show them how to push the seeds into the fine soil until each seed is about a half inch below the surface.

4. After the six seeds have been planted, guide children's attention to the picture on page 97. Call on someone to describe what is being done in the picture. Then ask whether or not it looks as though both cups are getting the same amount of water.

For verification of the children's responses, have them read the sentences at the bottom of the page. If children are sufficiently advanced in reading, suggest that they read the sentences silently to find out what to do in Step 4 of the investigation. In any case, have individuals read each line aloud, with your help, if necessary.

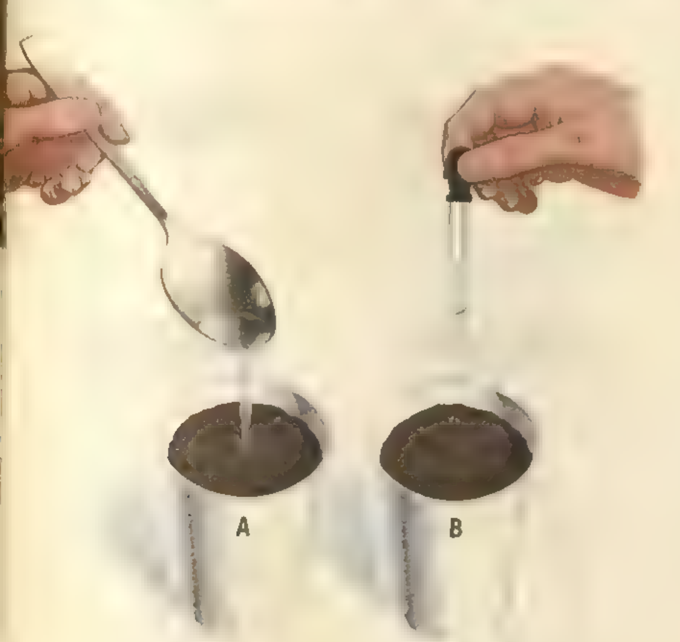
Show the class how drops of water can be squeezed from a medicine dropper. Then choose a child to come forward, take the dropper, and practice squeezing out individual drops while counting them. Give several children an opportunity to handle the dropper, squeezing out 5, 10, or 15 drops each. Choose one child to squeeze enough drops of water to fill a tablespoon. Then pour it into the soil in cup *A*.

Have someone reread the first line: "Give cup *A* one spoonful of water." The children will see that this has been done.

Have a child reread the second line: "Give cup *B* one drop of water." Call on a child (who has already practiced) to squeeze a single drop onto the soil in cup *B*.

Then ask everyone to reread the last line to remember how often the watering is to be done. Let the class decide on some particular time each day for adding drops to the soil in the cups. The cups should be kept in a warm, shady place.

(Either now or later, ask for volunteers to continue the investigation on Saturdays and Sundays. There undoubtedly will be children eager to take the cups home with them on Fridays. Choose one child to put the spoonful in cup *A* and another the single drop in Cup *B*. Others may wish to take the cups the second week.)



Give cup **A** 1 spoonful of water.

Give cup **B** 1 drop of water.

Do this every day.

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Help the pupils to summarize what they know about the two cups and their contents:

> The two cups are alike in most ways: both contain fine soil; both are planted with bean seeds; both are in a warm, shady place; both are receiving water every day.
>
> The two cups are different only in the amount of water they are receiving; cup *A* gets *much* more water than cup *B*.

Let children tell what they think will happen in cup *A* and in cup *B*. Encourage them to base their expectations on what they know (from Unit Seven) about water causing seeds to sprout as well as on the conditions within the two cups.

Children may reason that the seeds in both cups will sprout since both cups are receiving water; or that the seeds in cup *A* (or cup *B*) will sprout first; or that only those in cup *A* (or cup *B*) will sprout. At this time do not attempt to clarify their predictions. Instead, simply remind the class that they are doing an investigation. They are going to find out for themselves what happens to the seeds in the two cups.

Extending the Concept

Through Investigation. Plant various kinds of seeds in paired cups and follow a tablespoonful versus one-drop program of watering. It may be desirable to print the names of the seeds on the cups. Compare results with those obtained from the investigation begun in the lesson.

Through Activity. Using a variety of seeds, make an observation sprouting garden. Line a cardboard candy box with aluminum foil. Put a thin layer of absorbent cotton on the bottom of the box. Sprinkle the cotton till it is thoroughly wet but not soggy. Then place the dry seeds on the wet cotton. Arrange the seeds in even rows, each kind of seed in its own row. Cover the box with a sheet of glass (taped around the edges for safety) or with clear plastic. Place the candy-box garden in a warm but shady place and encourage children to observe the swelling of the seeds as they absorb water, the splitting of the seed coats, the emerging of the root ends, etc. (You may also find that mold begins to grow on some of the seeds. If so, what a wonderful opportunity for children to compare the growth of new plants from both seeds and spores!)

As soon as most of the seeds have sprouted, punch a few small holes in the bottom of the box for drainage, and then sift some good soil (humus) over the sprouts. Keep the soil damp and leave the candy-box garden in the shade till the plants have pushed up through the soil. Then move it to a place where the plants will receive sun for at least a few hours a day.

Through A Field Trip. If possible, conduct a short field trip to show the relationship between the growth (good or poor) of plants and the absence or presence of soil that holds water.

LESSON 2, page 98

SUBCONCEPT: Water is essential to the survival of living things.

Aim of the Lesson

To interpret from investigation (Lesson 1) the need for a certain amount of water for the sprouting of seeds.

Introducing the Lesson

NOTE: Unless there is a span of several days between Lesson 1 and Lesson 2, the bean seedlings in the cups will not be visible. In that case, you may wish to use the pictures and story of Lesson 2 and use the results of the investigation a few days later as a verification of Lesson 2.

REQUIRED: cups *A* and *B* from the investigation begun in Lesson 1. Review briefly the investigation of Lesson 1.

Choose several children to examine cups *A* and *B* to see whether or not there are any signs of sprouting. Have them tell what they see. Lead to these questions to be considered in the lesson:

If any of our seeds are sprouting, what caused them to sprout? Why are some (or perhaps all) not sprouting?

Developing the Concept

(by emphasis on the subconcept)

Have the children look at page 98. Explain that the pictures represent steps or stages in an investigation like the one they are doing.

Ask the class to look at all the pictures on the page to notice the important difference between cup *A* and cup *B* in each picture. The children will see that only in cup *A* are the three seeds sprouting and growing into plants. Nothing seems to be happening in cup *B*.

Now direct attention to the question on the page, **What makes the difference?** The children may need to be reminded of the medicine dropper and the basin of water. Then they will recall that cup *A* received a tablespoonful of water a day, but cup *B* received only a single drop. They will realize that the amount of water makes the difference.

If there has been sufficient time since Lesson 1 for sprouting to be evident in the class investigation, encourage the children to compare their results with those shown on page 98. Have them choose the picture that most closely resembles the appearance of their bean plants.

If no sprouting is apparent in either cup, help children to find reasons why their seeds apparently are not growing.

Perhaps there has not been enough time. It takes from a few days to a week for a bean seed to sprout and show above ground.

Perhaps the air in the room is so warm and dry that the tablespoonful of water evaporates rapidly and goes into the air instead of staying in the soil. The water is not reaching the seeds.

If nothing happens after a week or so, you may wish to start a new investigation, using more water.

By comparing the class results with those shown on page 98 and by discussion and experimentation, the children should reach these understandings:

To sprout, a seed needs water.

When a seed is planted in soil, it needs to get water from the soil.

If a seed does not get enough water from the soil, it does not sprout.

To evaluate the children's comprehension, present a story with questions such as the following:

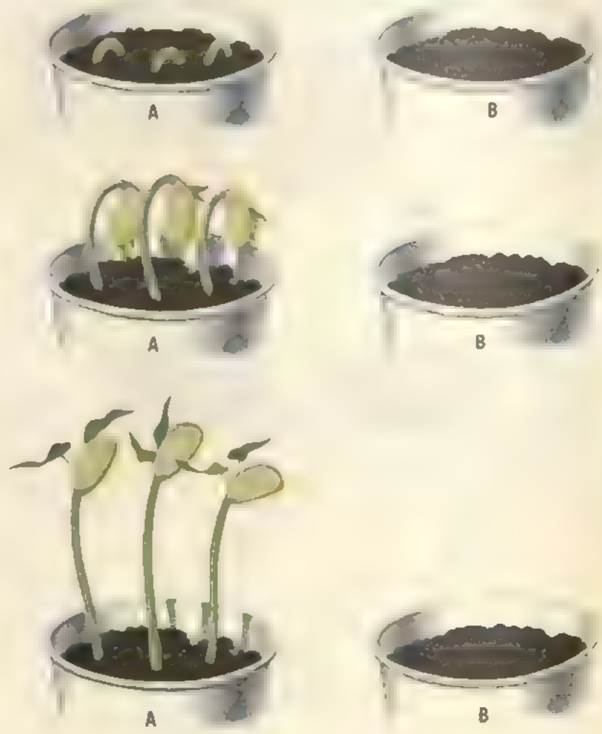
A squirrel buried an acorn in some dry earth under a porch. The porch protected the acorn from the cold and the rain. Another squirrel buried an acorn at the edge of the woods, where the snow fell in the winter and the rain fell in the spring. **Which acorn grew into an oak tree? Which acorn did not grow? What made the difference?**

Extending the Concept

Through Investigation. Place different kinds of dry seeds in shallow saucers or jar lids. Cover the seeds with water. Throughout the day, let small groups of children observe the seeds swelling and changing as they soak up water.

Through Investigation. Prepare a third cup in the same way that cups *A* and *B* were prepared. Label it *C*. Each day, fill cup *C* to the top with water, and keep it filled. Let children discover what happens when seeds receive too much water. (Too much water "drowns" the seeds. Without oxygen from the air, the wet seeds may rot instead of sprouting.)

Through Audio-Visual. This a good time to use the film entitled, "What Plants Need For Growth," available from Encyclopædia Britannica Films. Simple investigations are used to show the basic needs of plants and their reactions to favorable and unfavorable environments.



What makes the difference?

LESSON 3, page 99

SUBCONCEPT: Water is essential to the survival of living things.

Aim of the Lesson

To emphasize the importance of water in the continuing growth of a green plant.

Introducing the Lesson

REQUIRED: a geranium or other kind of potted plant.

Display the plant in front of the class and ask children how the plant is cared for in the classroom. Children will recall that the plant is watered regularly. Ask: **What would happen to the plant if we forgot to water it for a week or more?**

Developing the Concept

(by emphasis on the subconcept)

1. Have children look at the picture at the top of page 99. Ask whether or not they think this plant is growing well. Then ask why they think the way they do. Help them to consider the many green leaves, the straight stem, and the fresh-looking flowers as evidence that this is a healthy plant. **What kind of plant is it?** If there is a geranium plant in the classroom, have the pupils compare its leaves, stem, and flowers with those shown in the picture.

Next, direct attention to the story beside the first picture. Call on individuals to read the four sentences (helping them if necessary). Then present a few questions to be answered by referring to the picture and to the story. You may wish to use questions somewhat like these:

Is this plant growing in a dark place or in a well-lighted place?

Is it growing indoors or out?

Do you think that someone takes care of this plant? Why do you think so?

What is someone doing for the plant every day?

Through such questioning and some discussion, try to develop these understandings:

The plant is growing in soil.

It gets plenty of sunlight.

It gets enough water.

It is growing well (it is a healthy plant).

2. Then guide attention to the picture on the bottom half of the page. Call on children to point out differences between what is shown in this picture and in the one above.

Choose individuals to read the four sentences in the story below the picture. Have children demonstrate with heads and arms what it means to *droop*. Then present some questions about the picture and the story:

Is this the same plant as the one in the first picture? How can you tell?

Is the plant still getting sunlight? How can you tell?

Does the plant have *everything* it needs? Read the line that tells us that it does *not*.

Now read the last line and answer the question.

Encourage the children to speculate as to how it could be possible that the plant is not getting the water it needs. (The plant's owner may have forgotten or may have had to go away. The plant was not watered, and so it began to droop.)

After studying the two pictures and discussing their respective stories, children should be able to express the following idea in their own words:

A plant begins to droop when it is not watered; to grow well, a plant needs water.

Ask children to imagine what will happen to the plant if no one ever waters it again. They will realize that the plant will continue to droop more and more until it dies; it cannot live without water. Suggest that perhaps the plant has just begun to droop. If someone begins to water the geranium at once and continues to water it regularly, it may again look like the plant in the first picture.

Extending the Concept

Through Investigation. Place a small potted plant in a sunny spot and refrain from watering it until the plant begins to show the effects of lack of water. Then resume watering and watch the plant perk up.

Through Investigation. Punch small holes in the bottom of two frozen-juice cans. Fill one can with sand and the other with a good planting soil, such as humus. Stand each can on a small drinking glass. Then pour equal amounts of water into the two cans. As the water drains from the cans into the glasses, children will see that the good planting soil holds more water than the sand does. The soil holds the water, which can then be used by seeds or plants that are placed in the soil.

The plant has green leaves.
It has pink flowers.
It grows in the sunlight.
It gets water every day.

Something is wrong.
The leaves and flowers droop.
The plant needs something.
What does it need?

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LESSON 4, pages 100 and 101

SUBCONCEPT: Water is essential to the survival of living things.

Aim of the Lesson

To study the effects of rain on the growth of plants in a desert.

Introducing the Lesson

Write *desert* on the board and help children to recall the nature of a desert. It may be desirable to have them look again at page 47 in Unit Five. Many first graders will not have seen a real desert but some class discussion may prove useful. From the discussion, children will get the idea that a desert is a place that receives very little rain. Lead to this question:

What happens when it does rain on a desert?

Developing the Concept

(by emphasis on the subconcept)

1. Invite children to study the top picture on page 100. Guide their observations by presenting questions:

How does the sky look, sunny or cloudy?

How does the ground look, wet or dry and dusty?

Why does everything look so dry? What kind of land is this?

What do you notice about the plants that are growing on this desert?

Do they have many bright green leaves? Do they have any flowers? Do you see any bright green grass? Why is there no green grass?

Can you tell us something about the plants in the desert?

Encourage children to interpret the scene as showing plants that can grow with little water and with long periods of no water. Plants like our lawn grass or geraniums need to be watered often and cannot grow naturally in a dry place such as a desert. (NOTE: In the next lesson, where irrigation is introduced, children will see that many kinds of plants can grow well even in desert soil, when water is brought to them.)

Through discussion and study of the top picture, children will discover that certain kinds of plants can and do grow on a desert. Such plants need and receive very little water.

2. Next, direct attention to the picture on the bottom half of the page. Call on someone to tell what he sees in this picture. Children will recognize the heavy downpour of rain. They may be surprised to see that rain is falling on a desert.

At this point, explain about deserts and rainfall: The deserts in our country are located mostly in the western part. They are very dry most of the year. The picture at the top of page 100 shows what a desert may look like most of the year. In the spring, however, there usually are a few heavy rains. Dark clouds are blown across the sky, and the rain really pours down. It washes the dust from the desert plants, runs over the desert rocks, and then sinks into the dry, sandy soil. Sometimes the rain continues for several days. Then it clears up, the Sun comes out, and there is no more rain until the following spring.

3. Soon after the spring rain, the desert begins to look different. Many things change. The desert then looks as it does in the picture on page 101.

Have the children look closely at the picture while you explain that the bright, flower-filled scene represents the desert shown at the top of page 100. Now they see that the desert is beautiful after a rain. Encourage children to enjoy the beauty of the scene, picking out colors, describing the small blossoming plants, and noting the ways in which the plants shown in the first scene have changed.

Then ask children to think about questions such as these:

Where do you think all the tiny blossoming plants came from? How did they get started?

What made the big plants (desert shrubs) change?

From experience with sprouting seeds, children will realize that there must have been many seeds on or in the desert soil, that water from the rain wet the seeds, and that the seeds then sprouted and grew quickly into new plants.

They will also reason that the drab, dry-looking plants, shown in the first picture, changed when their roots received water. Some grew new leaves; some burst into bloom.

Choose a child to read the question at the bottom of page 101. Ask the class to think of one word (*rain* or *water*) that answers the question.

Through further discussion, try to establish an understanding of the following events and relationships:

Dry seeds are in the desert soil. They keep alive but do not sprout when they are dry.

When rain comes, the seeds soak up water. They sprout and grow into new plants.

The large plants also soak up water and start to grow again.

The plants have flowers and seeds. In time, the seeds fall to the ground, and the small plants dry up and die. The dry seeds do not sprout until it rains again.

Check children's comprehension of the lesson by presenting a problem for discussion: There are some desert places in other countries (parts of the Sahara, for instance) where rain never falls. The Sun shines and the wind blows, but there is no rainfall — no water. **What kinds of plants would you expect to see growing in such places?**

If the children really understand about a plant's dependence on water, they will reason that where there is *no* water there can be *no* plants.

Extending the Concept

Through Activity. Encourage children to bring in pictures and books about deserts, desert plants, and desert animals. Prepare a desert display. If possible show different kinds of deserts: low, fairly level deserts; high, rocky deserts; desert sand dunes (Death Valley or Sahara) where the absence of vegetation is apparent. (Colored desert pictures of exceptional beauty appear frequently in the magazine, *Arizona Highways.*) Perhaps you can secure Walt Disney's film "The Living Desert."

Through Investigation. Secure a packet of desert flower seeds. These are available at the seed counters in dime stores and at garden-supply shops. Prepare a sandy seed bed and plant the seeds, following instructions on the packet. Let children observe some of the various plants that spring up from seeds after a desert rain.

Through Investigation. Fill a small flower pot with top soil (very shallow) taken from a garden or a weed patch. Remove any plants you see growing in the soil. Water the soil, and cover it with an inverted drinking glass or a transparent plastic jar to form a little greenhouse. Children will enjoy observing the water cycle within the greenhouse. After a few days, they will notice plants beginning to grow in the soil. Encourage a discussion of these questions: **Where do the plants come from? How did the seeds get planted? Why are the seeds growing now into new plants?**

Through Following Up an Investigation. If lima bean plants are now growing in cup *A* (Lesson 1) and no sprouting is in evidence in cup *B*, change the daily watering procedure. Stop watering cup *A* and observe what happens to a nondesert plant during a dry spell. Begin to water cup *B*, keeping the soil damp, but not soaking wet. Find out whether the seeds will grow into new plants now that they are receiving more water. (If the seeds do not begin to sprout after four or five days, dig them up and try to find out what has happened.)

Contrast the beans and their dependence on frequent watering with the desert plants and their ability to live through long periods of drought.

What makes the difference?

LESSON 5, pages 102 and 103

SUBCONCEPT: Water is essential for the survival of living things.

Aim of the Lesson

To study the effects of irrigation in arid regions.

Introducing the Lesson

Develop the idea of irrigation (without using the word) by asking what we do to keep our lawns green when there is no rain for a long time (use parks and golf courses if children do not have lawns). As children discuss watering with hose and sprinkler, ask what might happen if there were a really big sprinkler that could be used to water a whole desert as the rain does. **Could green lawns and trees and vines and other kinds of plants grow on a desert if the plants got plenty of water whenever they needed it?**

Is there any way of getting plenty of water for big pieces of land?

Developing the Concept

(by emphasis on the subconcept)

1. Guide children to the first picture on page 102. Call on someone to tell what kind of land he sees in the picture. Through appropriate questioning, develop the idea that the picture shows a dry place (perhaps a desert), as on page 100.

Ask what the men are doing. Help the children to identify the pipe lines and the upright sprinklers. Challenge the class by speculating about the purpose of the pipes and sprinklers. **Is the owner of the land going to plant trees? Is he going to put up a big building? What will the pipes be used for?**

2. Some alert children may notice the picture at the bottom of the page where water is shown flowing from the sprinklers. Have the class look at this picture while you explain that the water may be coming from a big lake far away or from a pond nearby. The water runs (is pumped) through big pipes or flows in ditches (or canals) from the lake or pond. Ask what is happening in the field. The children will see that men are planting rows of what appear to be bare branches or dead plants.

3. Now direct attention to the picture at the top of page 103 and ask what is happening to the branches that were planted. **Are they still bare?** Children will see that in this picture the branches are growing. They are now covered with bright green leaves. Ask how these plants with their bright green leaves can grow so well in ground that was practically bare in the first picture. Through discussion, help children to realize that the plants are growing now because water has been supplied.

4. Suggest that the children look carefully at the picture at the bottom of page 103 to find out the kind of plants that are growing. **Are they grass plants? bean plants? trees? vines?** Call attention to the fruit to help children to discover that the plants are grape vines.

Explain that grape vines grow best where it is warm and sunny. They can grow well in sandy soil. **However, in order to grow well in a warm, sunny place and in sandy soil, what else do they need?** Children will be eager to answer the question.

Have the children recall the investigation of Lesson 1 and the watering of the bean seeds. Then ask them whether they think the sprinklers are working all the time (see illustrations). Try to bring out the idea that the sprinklers are used to get water into the ground. More water is needed in places where it is hot and dry.

Give the children time to look once more at the four pictures on pages 102 and 103 so that they can visualize how water can change the looks of a desert or any dry unproductive piece of land. Then, through questioning, bring out the fact that when water is brought to a place that does not get enough rain to grow plants, the land can be used to grow crops. With water, the barren land shown in the first picture on page 102 is made to grow delicious grapes as shown in the last picture on page 103. Farmers in many parts of our country find it necessary to bring water to their crops because there is not enough rainfall at the right time.

In summarizing the lesson, ask questions that will help children to express these ideas in their own words:

When water is brought to dry land, plants grow well there.

When water is brought to desert land, plants other than native desert plants can be grown.

Water makes dry land useful for growing plants that provide food.

Check for understanding of the role of water in enabling the grape vines to grow by asking what would happen if there were no regular rainfall and no water flowing through

the sprinklers as shown in the picture. **Would the bare branches then grow into big, leafy vines and produce grapes?**

Children will reason correctly that without water getting into the soil, the grape vines could not grow.

Extending the Concept

Through Activity. Put enough dry sand in a glass tumbler to fill about half of the tumbler. With a plastic sponge, sprinkle water over the surface of the sand. Have the children watch the water sink rapidly to the bottom. Continue to sprinkle until the water shows about half-way to the top of the sand. Let the tumbler stand on a sunny window ledge for a few days, and then have the children look at it. **What has happened to the water? If we wanted to sprout seeds in the sand, what would we need to do again?**

Through a Field Trip. If possible, take the children to see an irrigation system at work. If you are in an urban area, you may wish to visit a greenhouse or nursery to observe the overhead sprinkling system. Seeing any watering system in operation will further impress children with the importance of water in raising plants.

Through Investigation. Place a plastic sponge in water in a shallow pan. Sprinkle some mixed bird seed on top of the sponge. Let children examine the seeds through a magnifying glass. They will observe that when water is kept in the pan, the sponge will remain wet. In a few days, the seeds, lying on the wet sponge, will sprout and grow into various kinds of wild grass plants. The plants on the sponge will get water that soaks up from below, just as plants which are growing in desert land watered by means of ditches.

What makes the difference?

UNIT NINE: LIVING THINGS GROW

Section 2: Animals in Good and Poor Environment

CONCEPT
There is an interchange of matter and energy between living things and their environment.

LESSON 6, page 104

SUBCONCEPT: Food is essential to the survival of living things.

Aim of the Lesson

To investigate the dependence of animals on their environment.

Introducing the Lesson

Initiate a discussion of an animal's dependence on food by referring to an animal that was studied in Unit Eight. If the children are currently caring for animals in the classroom (goldfish, tadpole, white rat, snail, worm, chick, etc.), refer to one of these. The animal is now getting food. **What would happen if the animal were given only a small part of the food it is now getting?**

Developing the Concept

(by emphasis on the subconcept)

1. Have the children look at the cattle in the picture at the top of page 104. Ask what the cattle are doing. Children will respond that some of the cattle are feeding on grass; some are drinking water from the stream.

2. Next, direct attention to the cattle in the picture at the bottom of the page. Ask what these cattle are doing. The children will see that these are also feeding on grass, but there is no stream from which they can drink.

Now have the children look carefully at the cattle in both pictures to find out if they are the same kind of cattle. **Are they the same color? Do they have the same kind of marking? Do they look alike?**

By comparing and discussing the two pictures, help children to reach these assumptions:

Both pictures show reddish-brown cattle (Herefords) with white markings.

The cattle in the top picture look big and fat.

The cattle in the bottom picture look small and thin.

Ask the children to study the two pictures again and find *one* reason why the cattle in the bottom picture are not as fat and healthy looking as those in the top picture. The children will observe the abundance of green grass in the top picture and compare it with the sparse growth in the bottom picture. They will then recognize that the difference in amount (and quality) of food is a reason for the difference in the conditions of the cattle in the two pictures.

Conclude the lesson by returning to the discussion of a classroom animal and its food (Introducing the Lesson). **What would happen if one of our animals could not get the food it needs? What would happen if it could not get any food?**

From discussion of these problems and of the cattle in the two pictures on page 104, children may be led to generalize along the following lines:

If an animal gets enough good food, it grows well and is healthy.

If an animal does not get enough food, it does not grow well.

If an animal gets no food, it dies.

Animals depend on food (and water).

Extending the Concept

Through Investigation. Assign children who have pets the problem of finding out what the pets are fed each day. When children report on the diets of their dogs, cats, birds, etc., discuss the foods these animals depend on. Then trace each food to its original source: plants. (Canned dog food contains meat products from beef and horses, which feed on plants. Cat food may contain fish products. Large fish feed on smaller fish, which feed on still smaller fish, etc. The smallest sea creatures in the food chain feed on tiny plants that grow in the sea. Birds eat seeds of grass plants.)

What makes the difference?

LESSON 7, page 105

SUBCONCEPT: Food is essential to the survival of living things.

Aim of the Lesson

To reinforce, by means of a story, the fact that an animal's welfare depends upon its environment; that a domesticated animal depends on a special aspect of the environment — man's care.

Introducing the Lesson

If you have ever attended a county or state fair, tell the class about it. If any of your pupils have attended, invite them to share the experience with the class. Explain that adults and boys and girls bring animals and produce to the fair. Judges award prizes and ribbons (first prize, a blue ribbon).

Developing the Concept

(by emphasis on the subconcept)

1. Have children look at the story and the pictures on page 105. Before the story is read, ask children to tell what they think the story is about. They will see that the story deals with a little girl and a calf.

Read the first paragraph of the story while the children follow the words. (If the class is sufficiently advanced in reading skills, you may prefer to choose children to read the sentences or to have the class read the first paragraph to themselves.)

Mary had a little calf.
She led it to the pasture.
The calf fed on green grass.
He drank water from a stream.

At night the calf
came to the barn.
Mary brushed his coat
and fed him oats and hay.

Mary took her calf to the Fair.
The calf won a big blue ribbon.
It was the best calf in the Fair.

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Why do you think Mary took her calf out to the pasture?

What did the calf eat in the pasture?

Where did the calf get water?

2. Follow a similar procedure with the two sentences in the second paragraph. After the reading, you may wish to pose these questions:

Did Mary leave her calf in the pasture all night?

Where did she lead it?

What did Mary feed her calf in the barn?

What did Mary do to help her calf's coat look good?

3. Repeat the procedure with the three sentences in the last paragraph, following with questions similar to these:

What happened when Mary took her calf to the Fair?

What do the words on the blue ribbon say? (Direct attention to the picture beside the paragraph.)

How do you think that Mary felt when her calf won the first prize ribbon?

Try to develop the idea that Mary had given her calf a great deal of personal care. **What are some of the things that Mary did to help her calf to grow so well?** Through discussion, try to get children to express these ideas:

Mary gave her calf plenty of food. The calf fed on grass in the pasture and on oats and hay in the barn.

Mary took her calf to a place where there was plenty of fresh water to drink, and a cool, shady place to rest when the Sun was hot.

She brought the calf into a barn for the night.

She brushed its coat and helped keep it clean.

The calf grew well because it was well cared for; it had all the things it needed.

Check children's comprehension of the main idea of the story by presenting the following situation for discussion:

Suppose Mary forgot some days to take her calf out to the pasture and to see that it had water. Suppose she did not feed it oats and hay every night. Suppose she didn't brush its coat and didn't keep it clean. Do you think that Mary's calf would have won the blue ribbon?

Children will show their understanding by reasoning that without proper food and care Mary's calf probably would not have won first prize, or any prize.

Extending the Concept

Through a Sharing Period. Invite children to tell about the care they give their pets at school or at home. Use the information to establish the dependence of animals on their environment (for food, water, air, warmth, shelter).

Through Activity. Encourage children to bring in pictures of healthy animals from magazines. Use the pictures for a bulletin board display or a chart headed "Animals that grow well. They get the things they need."

Through Language. During a language period, have the class compose a short story about taking care of some kind of animal. Letter the story for use in a reading lesson.

Through Art. Suggest that children make pictures to illustrate the class story (above). Use one or more of the pictures on the chart.

UNIT NINE: LIVING THINGS GROW

Section 3: Classroom Aquarium and its Care

CONCEPT
There is an interchange of matter and energy between living things and their environment.

LESSON 8, pages 106 and 107

SUBCONCEPT: Plants and animals interact through a food chain relationship.

Aim of the Lesson

To give the children experience in setting up a balanced aquarium for the classroom.

Introducing the Lesson

REQUIRED: a clean, empty aquarium. If no tank aquarium is available, use a fish bowl or a large glass jar with a wide mouth.

. Show the ***aquarium*** to the class, and ask what it might be used for. If children do not quickly think of having fish in the classroom, prompt them by pointing out that the tank or bowl can be filled with water. Then introduce the question:

What things will be needed for an aquarium in which goldfish will grow well?

Developing the Concept

(by emphasis on the subconcept)

NOTE: Ideally, this lesson should include a field trip to a pet store to help children find out what is needed for an aquarium (sand, water, goldfish, snails, and plants). However, if you do not find it practical to take the class on a field trip, you may secure the supplies for the aquarium as they are needed: first the sand, and then, about three days later, the fish and snails. Each fish that measures one inch, exclusive of tail, needs a gallon of water; for every fish with a two-inch body, allow two gallons of water; etc. One medium-sized snail may be added for every gallon of water. The pet shop dealer will advise you about the amount of plant material (vallisneria, elodea, and cabomba) needed to balance your aquarium. (Also, see pages 46–47 — *A Sourcebook for Elementary Science*, by Hone, Joseph, and Victor; Harcourt, Brace & World, Inc., 1962.)

If the class is to go on a field trip to make purchases, open the lesson with a discussion of the trip to the pet store. In any case, mention and discuss each item that will be used in the aquarium. Guide thinking by presenting questions like these:

What shall we put on the bottom of the aquarium as a start?

What are two kinds of animals that are going to live in the aquarium?

Do we need any plants? Do you think we should have different kinds of plants?

What should an aquarium have in it in the largest quantity?

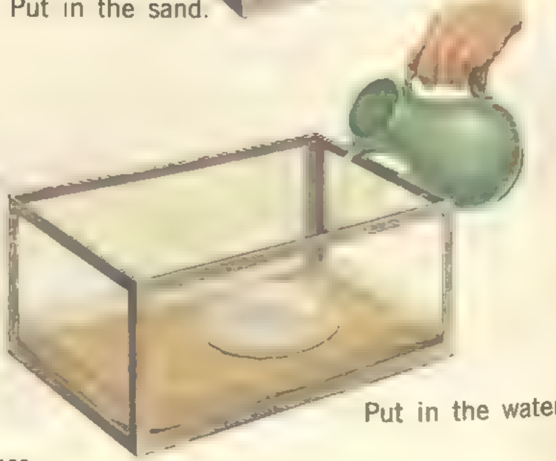
Children will respond that water will also be needed and will understand that this need not be purchased or brought from outside the school.

1. Now have everyone look carefully at the first picture on page 106 to find out what should go into the aquarium first. Choose a child to read the sentence under the picture. Then have several children spread the sand on the bottom of the tank (about one-half inch thick). A few small stones and perhaps a shell or two are desirable.

2. Next, direct attention to the bottom picture, and have someone read the sentence under it. Place a small plate or a saucer on top of the sand. Try to get the children to discover for themselves, from studying the picture, that the plate is used to prevent the sand from being stirred up too much when the water is poured in. If running water is available in the classroom, let children take turns filling a pitcher and emptying it rather slowly over the plate in the aquarium. If the aquarium must be filled from a bucket that is rather heavy, you may have to do the actual filling while the children observe. The aquarium should be filled with water to about two inches from the top. Then tell the children that they must wait for *three* days.

This may be disappointing news to the children, who will be most eager to put in the plants, fish, and snails at once. Take time for a discussion of the problem involved, which necessitates waiting for three or four days.

Put in the sand.



Put in the water.

Why is it necessary to wait before we put in the living things?

Children will notice that the water is somewhat cloudy (from the sand) and may offer the logical suggestion that we should wait till the water is clear. This is good reasoning. However, it usually takes only a few hours for the sand to settle, and so there must be some other reason for a three-day wait.

Children may be able to reach another reason for the waiting period if they are presented with a few questions, such as the following:

Where did we get the water we used to fill our aquarium?

What do we usually do with water we get from a faucet (or a drinking fountain)?

Do we usually drink water that has fish, snails, and plants living in it?

Do you think there is some difference, then, between water we drink and water that fish live in?

At this point, it will probably be necessary to explain that something (usually chlorine) is added to the water we drink to keep it free from germs. The something that is added makes our water fit for drinking, but not good for plants, fish, snails, and germs. When we let the drinking water stand for three days, much of the material that was added to it goes into the air — it evaporates. Then the water is fit for animals and plants to live in. The water will also be at room temperature, whereas water fresh from the tap may be too cold for goldfish.

3. After the three days have passed, begin the next part of the lesson. Direct attention to the top picture on page 107. Have someone read the sentence under it. Call on a child to describe, from the picture, how the plants are to be placed in the sand. Choose children to plant each of the water plants. Give any help that may be needed to get the root ends well into the sand without crushing the plants. It is advisable to anchor the root ends with some well-washed stones.

4. When the plants are all in place, have the children study the bottom picture on the page to find out what is to be done next. Call on someone to read the sentence under the picture. Call on other children to describe, from the picture, how the fish and snails are to be placed in their new home. As the picture shows, the animals are introduced into their new environment from the container in which they were purchased. The fish will leave the container as the water in the aquarium and in the container equalize in temperature. The snails may be placed directly on the bottom and sides of the tank.

Summarize the filling of the aquarium by presenting some questions for discussion:

What two kinds of animals do we have in our aquarium?

What other living, growing things do we have in our aquarium?

Why do we need water in the aquarium?

In the discussion of the above questions, children will explain that the classroom aquarium now holds sand, water, plants, and animals (fish and snails). They will also be able to explain that the fish, snails, and the water plants need water in order to live and grow.

Check for understanding by asking whether the goldfish could live in a bowl that contained sand, green plants and air. If necessary, refer to Unit Eight in which the children learned that fish use gills to get air from water; they cannot breathe air from the atmosphere as we do. The children will reason that the goldfish can live only in water.

Extending the Concept

Through Key Concept Words. Add *aquarium* to the Science Vocabulary Chart or to the Animal ABC Book (Unit Eight).

Through Investigation. Secure some large fish scales from a fish market. Put them in water in shallow saucers, and let children examine them through magnifying glasses. If the scales are sufficiently developed to show growth rings, point them out to the children, and explain that a new ring forms each year. Let children speculate as to the age of the fish on which the scales grew.

Through Arithmetic. Explain that for every inch that one fish is long, a gallon of water is needed in an aquarium. Let children compute the number of gallons of water needed for three one-inch fish; for two one-inch fish, and one three-inch fish; etc.

In a few days put in the plants.

In a few more days put in the fish and snails.

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LESSON 9, pages 108 and 109

SUBCONCEPT: Plants and animals interact through a food chain relationship.

Aim of the Lesson

To study the conditions and care needed to maintain a balanced aquarium.

Introducing the Lesson

REQUIRED: the classroom aquarium.

Help the group to choose individuals or committees to care for the aquarium. Encourage children to look at the aquarium carefully as you present the problem:

What should we do to help the plants and animals in the aquarium to grow well?

Developing the Concept

(by emphasis on the subconcept)

Have the class think about the aquarium in the classroom by presenting a few questions:

How many fish does the aquarium have? How many snails?

Is there plenty of water?

Are the plants healthy looking?

Does the water look clean?

Help the members of the class to realize that they now have a responsibility for their own aquarium; they need to learn how to take care of the fish, snails, and plants.

At this point, direct attention to the story that begins on page 108 and continues on page 109. Call on a child to read the title. From the title, the children will understand that the story will tell them some things about caring for an aquarium.

1. Choose a child to read the first sentence. Then ask why the aquarium, in which the green plants are growing, needs light. If necessary, refer back to Unit Seven, Lesson 10 to have children recall what happens to plants that do not receive light. Ask them to imagine how the plants would look if the aquarium were kept in darkness. Children will understand that without light the green plants would become weak and pale; they would not grow well in the dark.

2. Have someone read the second sentence. Explain that too much bright sunshine may cause the water to become too warm for both fish and plants. Also, many tiny, dark green plants (algae) will grow in the water. They will make the water slimy and will cloud the glass. Have the children notice carefully the location of the classroom aquarium. **Does it receive light each day? Is it out of the hot Sun?** A few algae may grow anyway, but these few will be eaten by the fish and snails.

3. Call on someone to read the third sentence. Show children that "a little food," in this case, is a tiny pinch for each fish, just enough to be finished off by a fish in about ten minutes of feeding. If the fish do not eat all the food the aquarium will begin to look dirty and to smell. Give time during the discussion of each sentence for children to study and enjoy the related illustrations. Make comparisons of the fish feeding and the fish merely swimming about.

4. Now have someone read the fourth sentence. Ask children why we have plants in an aquarium with fish. **Since plants make their own food, why not have just fish without plants?**

Children may point out that plants make the aquarium attractive to look at, that they make it seem like a natural underwater home for the fish, or that they supply food for the fish. These are good ideas, but the essential role of plants growing in an aquarium may need some explanation. It is important that children know how plants contribute to the welfare of the fish:

> As the plants grow, they add something to the water. They make the water better for the fish to live in.
>
> Fish grow better in an aquarium in which plants are growing than in one without plants.

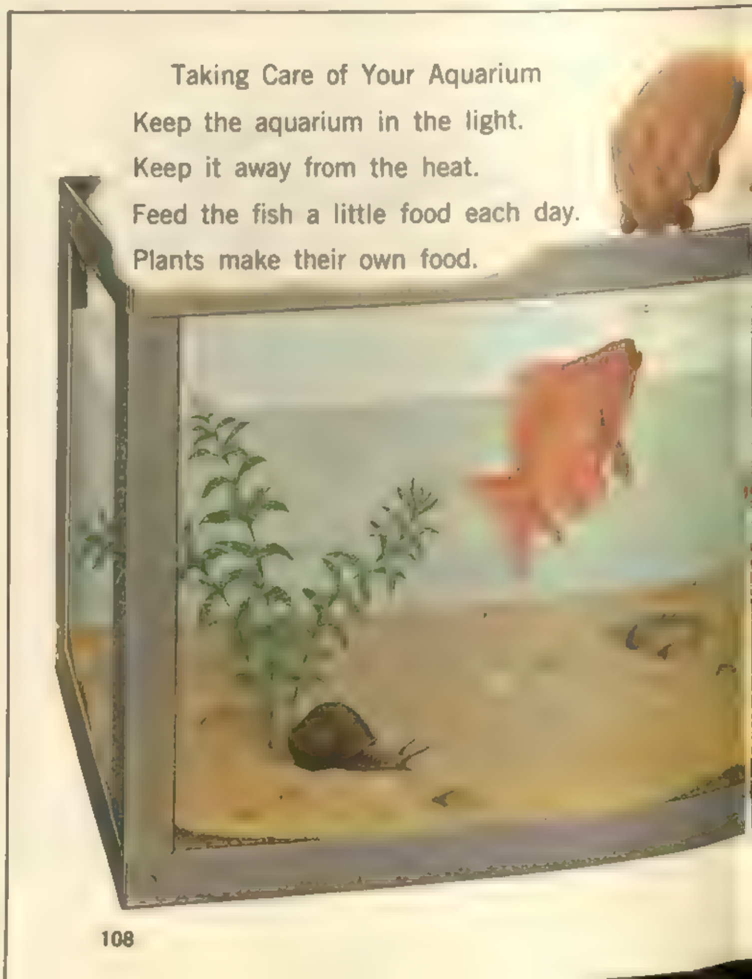
These two points, expressed in very general terms, are likely to be a sufficient explanation for most classes. Unusually alert children, however, may want to know more. They may ask what the "something" is that plants add to the water. If this happens, you may wish to present a few more details:

All green plants, growing in light, give off *oxygen*.

Oxygen is a gas that is in air. We cannot see the oxygen in air, but we can often see some very tiny bubbles coming from green plants that grow in water. These are bubbles of oxygen. Some of the oxygen stays in the water.

Fish use oxygen when they breathe. With their gills, they take oxygen from the air that is in water. When plants are growing in the water, there is more oxygen for the fish. Plants supply oxygen, and the fish use it.

5. Have a child read the fifth sentence: "Do not feed the snails." Then have the children look at the picture of the two



snails feeding on the bottom of the aquarium. Let a pupil read the sentence on page 109: "Snails find their own food on the sides and bottom."

6. Ask why it is good to have snails in an aquarium. For an answer, call on a child to read the sentence, "Snails help keep the aquarium clean." Call attention to the picture of the snail cleaning the glass side of the aquarium. Explain that the snails feed on old leaves that fall from the plants, bits of left-over fish food, other dead or left-over material that sinks to the bottom, and algae that cling to the sides. Snails serve as a clean-up squad, not intentionally, of course, but because of their feeding habits.

7. Now have someone read the last sentence in the story. Ask children to suggest ways in which they can help keep the aquarium clean. Guide thinking toward suggestions like these:

Give only as much food as the fish need each day.

See that there are enough snails in the aquarium to keep it clean.

Do not let the aquarium get too much direct sunlight or get too warm.

When dirt does collect in the aquarium, remove it, and clean the side walls.

To check comprehension of the "balance" in an aquarium, suggest a problem such as the following:

George had three bowls of water. In one he put two goldfish; in the second, three snails; and in the third, several water plants in sand. George said that the plants, snails, and fish all belonged to different groups of living things, so they should live separately. **Was George correct?** Explain why he was not correct.

Extending the Concept

Through Investigation. With a strip of adhesive tape, mark the water level on the aquarium. Let the children observe the lowering of the water level as evaporation occurs. Remember the three-day waiting period when replacing water in the aquarium.

Through Activity. Using some rubber tubing and a pan or bucket, siphon out some of the sediment-filled water from the surface of the sand, as needed, to keep the aquarium clean. Use this practical experience as an opportunity for children to discover how a siphon works. (To operate the siphon, fill the tube with water, hold both ends shut, with thumbs, submerge one end in the aquarium, and then hang the other end in a pan or bucket on the floor. Let go at both ends. Water will flow up from the aquarium and *down* into the container at a lower level.) Add water to the aquarium to replace the amount that is siphoned off.

Through Activity. Let children go to the aquarium in groups of four or five to observe a fish and a snail and compare them. Ask the children to find out:

How does a fish move? How does a snail move?

How does a fish feed? How does a snail feed? What do they feed upon?

What covers a fish's body? What covers a snail's body?

Through Activity. Let children experiment with tiny amounts of different foods: lettuce, yolk of hard-boiled egg, pinhead bits of raw liver. Find out which foods the fish will accept. Remove all unused food at the end of an hour.

Through Art. Suggest that children make colored pictures of fish and plants living together. Use the pictures for a class water-life frieze.

Do not feed the snails.

Snails find their own foods.

Snails help keep the aquarium clean.

You can help keep it clean, too.

UNIT NINE: LIVING THINGS GROW

Section 4: Differences in Size Due to Species

CONCEPT
Organisms (living things) reproduce their own kind.

LESSON 10, pages 110 and 111

SUBCONCEPT: The size and structure of an organism is determined by heredity and environment.

Aim of the Lesson

To help children to become aware of the relationship between an animal's species and the maximum size it can attain.

Introducing the Lesson

REQUIRED: an insect in a jar with a perforated cover, or some other kind of *small* animal in a cage.

Present the animal to the children and let them examine it. Ask what the animal's parents were like and what its young will grow up to be like. Use the animal as a basis for a review of the concept, "Animals reproduce their own kind," which was developed in Unit Eight.

Initiate a discussion of big and little animals. Let children name the largest and the smallest animals they have ever seen. Prompt them, if necessary, to help them think of such animals as the elephant, whale, hippopotamus, hummingbird, ladybug beetle, firefly, flea, gnat, etc. Lead children to wonder:

Could the tiny animals keep on growing till they were as big as the large animals? Could a ladybug beetle, for instance, ever grow to be the size of an elephant?

Developing the Concept

(by emphasis on the subconcept)

NOTE: This lesson may take more than one period, but it is important that children recognize the relative sizes. All the pictures on these two pages are drawn to the same scale.

1. Invite children to look at the top picture that extends across pages 110 and 111. Call on a volunteer to identify the kind of animal shown. Write ***whales*** on the board, and guide children to the word under the picture as they pronounce it.

Then ask whether the two whales are the same size. The children will reason that the picture shows a young whale and its mother.

Give children an opportunity to share any knowledge they may have about whales. Most children will not have seen a real whale. You may wish to help develop their understanding of whales by telling them something like the following:

The whale is the largest kind of animal that has ever lived. One kind of whale is so large that it probably would not fit in three classrooms put together. It is about as long as eight automobiles, bumper to bumper. **Do you see that a whale is really big?**

Whales live in water, which supports their huge, heavy bodies. A whale is helpless if it is washed ashore.

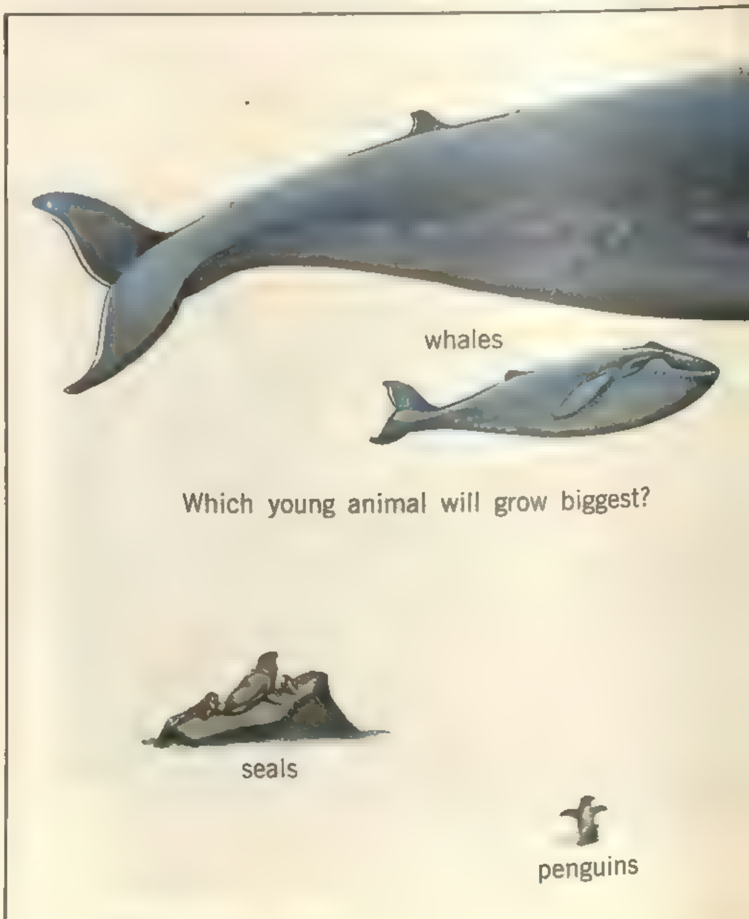
Although whales live in water, they are not fish. They do not lay eggs. They are mammals. They have lungs and breathe air as we do. They have to come to the surface to breathe.

A female whale usually gives birth to a young whale about once every two years. The baby whale, though much, much smaller than its mother, may be as big and as heavy as a trailer truck!

2. After a discussion of whales, guide children to the picture of the seals, and write the word on the board. Then help them to read ***seals*** under the picture. Explain that seals, like whales, are mammals. Their babies are called "pups."

Seals live in water and at the water's edge. They swim well and often stay under water for twenty or thirty minutes at a time. Eventually, they have to come up for air, because they breathe with lungs as we do. They often climb onto rocks to rest near the water. A full-grown seal may be as big as a person or even bigger. See how small the seal is as compared to the whale.

To emphasize relative size, have the children compare the size of the baby whale and the mother seal. Children will see that even the baby whale is much, much larger than the full-grown seal.



3. Next, direct attention to the picture of the penguin and ask children to tell what it shows. Write ***penguin*** on the board, and have the class point to the word in their textbooks as they pronounce it. After calling on children to tell anything they may happen to know about penguins, you may wish to offer further information:

Penguins are animals that have two short legs on which they waddle. They have wings but they cannot fly. Their bodies are covered with feathers. They are good swimmers, and they also like to slide on the ice, pushing themselves along with their feet. The female penguin usually lays only one egg a year. Ask what penguins are. **Are they fish? Mammals?** Help children to use the facts that penguins have wings and feathers and lay eggs as evidence that they are birds. Explain that some penguins, like the adult one in the picture, are as tall as or taller than a yardstick is long when they are full-grown.

Now have the children look at the three kinds of animals shown on page 111. Have them think of something important they can tell about *one* kind. Guide the children's thinking by presenting questions like these:

What kind of covering does it have on its body? a shell? scales? hair (at least some)? **feathers?**

How does it move? How many legs does it have?

Is it a fish? a bird? an insect? a mammal?

What will the "baby" be like when it is full-grown?

Call on volunteers to tell about the animals they have chosen. Through a discussion of children's comments, help the class to reach these assumptions:

All of the animals on the page have four legs and at least some hair (or fur).

They are all mammals, adult and young.

Each young mammal is the same kind as its parent.

Now choose someone to read the question at the bottom of the page. Write the numerals 1, 2, 3, 4, 5, 6, in a column on the board. Announce that we will now consider all the animals on pages 110 and 111. We will write the name of the animal that will grow biggest beside the numeral 1 and the name of the animal that will be smallest when it is full-grown beside numeral 6. We will write the names of the other animals in order of size, in their proper places.

Children will have no difficulty in choosing the whale as the biggest. Nor will they hesitate in choosing the penguin as the one that will be the smallest adult animal. Encourage discussion till agreement is reached about the order from largest to smallest: whale to penguin.

Now call attention to the picture of the baby ***elephant***, and point out the fact that it is now smaller than a grown-up horse. Ask *why* the baby elephant will grow to be bigger than a grown-up horse. Children will show their understanding by reasoning that a baby elephant grows up to be an adult elephant, and elephants are bigger than horses.

If some children seem to be unsure about this line of reasoning, present a few questions:

Could a mouse grow to be as big as an elephant? as big as a horse? as big as a seal?

If a baby mouse had plenty of food and everything else it needs, and if it were healthy and grew very well, how big do you think it might become?

Have children use their hands to show how big. Help them to understand that the little mouse could only become as big as a grown-up mouse. Likewise, the pig could become only as big as a grown-up pig, etc.

Through further discussion, lead the class to these generalizations:

Each animal is the same kind as its parents.

Each animal can become only as big as the biggest of its own kind, if the environment is good.

Test children's understanding by presenting for discussion a situation such as the following:

Suppose that someone captured a new-born seal and gave it to a mother whale to raise (or a colt to an elephant). Suppose that the mother whale fed the young seal and took care of it just as though it were a baby whale. **Then might the seal grow to be as big as a whale?**

Emphasize the relationship between the heredity of the organism and the environment (food, enemies, etc.).

Extending the Concept

Through Library Research. On a library table or shelf, have books and pictures about various kinds of animals. Encourage children to consult the books and pictures to find out more about the kinds of animals and where they live. Do not hesitate to spread out on the table many preschool picture books as well as animal books that are above first-grade reading level.

Through Key Concept Words. Add *whales, seals, penguins,* and *elephant* to the Science Vocabulary Chart or to the Animal ABC Book (Unit Eight).

Through Art. Have children make pictures that can be used to illustrate the Animal ABC Book.

LESSON 11, pages 112 and 113

SUBCONCEPT: The size and structure of an organism is determined by its heredity and environment.

Aim of the Lesson

To help children to become aware of the limits of heredity by the fact that a puppy grows to be a large or small dog according to its breed.

Introducing the Lesson

Initiate a sharing period in which children discuss dogs they have known. Encourage them to tell about the care of dogs, how dogs behave, and the differences in the appearances of various breeds. Try to develop the understanding that dogs differ greatly in size as well as in looks and in color. Some are so small that they can be held in the hands. Some are as large as a child, and some are larger. Lead up to the question:

Why do some puppies grow to be big dogs while others never get very big?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the picture at the top of page 112. Call on children to describe the scene shown in the picture. Through discussion, bring out the fact that the picture shows a large mother dog with four puppies. Choose a boy in the class to represent the boy in the picture. Have him come forward and then have other members of the class tell him where to hold his right hand to show the approximate height of the body of the mother dog, and his left hand to show the height of the dog's head. By comparing the size of the dog with the size of a boy, the children will realize that the dog is very big.

You may wish to use a yardstick and let children see how high the dog stands from floor to shoulders (about 30 inches). A dog of this size and breed weighs from 120 to 150 pounds. Children will be interested to compare the dog's weight with their own (the weight of two children or as much or more than the weight of the teacher).

Ask whether anyone knows the name of this kind of dog. If not, identify the dog as a ***Great Dane.*** Write the words on the board and explain that Great Danes are always very large, but are usually gentle and friendly. They get along well with little children and make good watchdogs. Great Danes were originally used to hunt wild pigs (boars) in the forests.

If any children own or have seen a Great Dane, invite them to share their observations and experiences with the class.

2. Next, have the children look at the picture on the bottom half of page 112. Call on someone to tell what the picture shows. Children may refer to the mother dog as a "wienie dog" or a "sausage dog." If so, help the class to recognize that the dog's long body and unusually short legs are responsible for those names. Identify the dog as a mother ***dachshund*** (daks'hoont) and write the word on the board for the children to pronounce. Explain that dachshunds are excellent diggers and originally were used to hunt small animals that lived in holes in the ground. (Dachshund means "badger dog" in German. A badger is a short-legged wild animal that lives in a hole.) Let children explain why these short-legged dogs would be useful for hunting small animals that live in holes.

Choose a girl in the class to represent the one in the picture. Have her come forward and show the height of the mother dachshund. (Perhaps the distance above a desk or a table will be more readily seen by the class.) Help children to compare the height of an adult dachshund with that of an adult Great Dane.

Ask children to look at both pictures on page 112 and decide on the answer to these questions:

What kind of puppies does the Great Dane have?
What kind of puppies does the dachshund have?

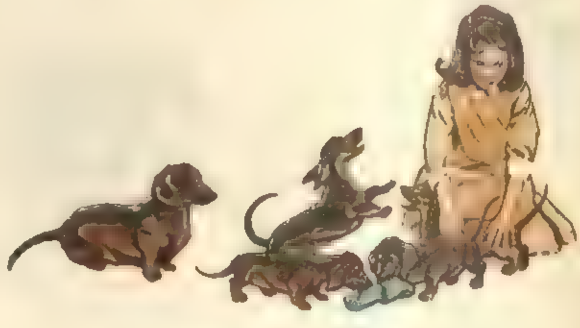
Children will quickly respond that each of the dogs has puppies of its own kind. The Great Dane has Great Dane puppies and the dachshund has dachshund puppies.

3. Then direct attention to the picture on page 113. Call on children to identify the two puppies — one a dachshund pup and the other a Great Dane pup.

Ask what the two puppies need in order to grow well. Encourage a discussion of the following needs:

plenty of good food
fresh air to breathe
plenty of clean water (or milk) to drink
a safe, warm place to sleep
exercise and play
protection from traffic and other hazards.

Ask the children to assume that both puppies get all the things they need. **Will both puppies grow? Will they both become grown-up (or adult) dogs? Will the grown-up dogs be the same size?**



Large and small

Children will reason correctly that with adequate food and good care, both puppies will grow bigger; they will eventually become adult dogs.

Then ask which one will be the bigger dog when it is full-grown. As soon as the children answer that the Great Dane puppy will grow into the bigger dog, remind them that *both* dogs receive the same good care and all the food they need. Why, then, does the Great Dane puppy grow faster and become so much bigger than the dachshund?

At this stage, some children may be ready to generalize:

> A dog grows the way its parents grew; it cannot grow to be as big as a bigger kind of dog; or it cannot remain as small as a smaller kind of dog.

To evaluate the children's understanding of the concept of this section, present the following story for discussion.

Billy always wanted a big dog. On his birthday, his uncle gave him a little puppy. Billy took good care of his puppy. He gave it plenty of all the things it needed. The puppy had a good appetite. It ate and ate and grew and grew. It grew to be bigger than Billy. When it was full-grown, Billy at last had what he wanted — a big dog, a Great Dane! **Why do you think Billy's puppy grew to be a big dog?**

Most of the children will realize, by now, that the amount of food a dog eats and the kind of care it gets do not determine the size to which the dog will grow. They will understand that the puppy's parents are Great Danes.

Extending the Concept

Through Key Concept Words. Add *dachshund* and *Great Dane* to the Science Vocabulary Chart or to the Animal ABC Book (begun in Unit Eight).

Large and small puppies

Through Arithmetic. Although your first-grade children may not have used numbers greater than 100, you may wish to have them compare the weights of a Great Dane and a dachshund by means of addition problems. For example, a Great Dane may weigh 120 pounds (100 pounds and 20 pounds more). A dachshund may weigh 20 pounds, so five dachshunds will weigh 100 pounds ($20 + 20 + 20 + 20 + 20 = 100$). Then one more dachshund (another 20 pounds) or six dachshunds, will weigh as much as the Great Dane ($100 + 20$).

Through Language. During a language period have children compose stories about their own dogs or about dogs they have known. The children might also dictate the content of a class chart on taking care of a dog.

Through Art. Have the children make pictures to illustrate their stories and chart.

Section 5: Effects of Heredity and Environment

CONCEPT
There is an interchange of matter and energy between living things and their environment. Adequate amounts of both are required for optimum growth.

LESSON 12, page 114

SUBCONCEPT: Hereditary factors develop within a given environment, but the characteristics of the species are not generally altered.

Aim of the Lesson

To study the effects of heredity and environment on the growth of plants.

Introducing the Lesson

REQUIRED: an apple and a tomato; a sharp knife.

Present the two whole fruits to the children for identification. Ask what will be found inside each fruit. Cut the apple and the tomato in half, and let the children see how the seeds grow inside and where they are in each fruit. Choose several children to remove some of the seeds. Bring up the purpose of seeds and lead to this question:

What could grow from apple seeds? from tomato seeds?

Developing the Concept
(by emphasis on the subconcept)

REQUIRED: a few seeds from an apple and a tomato.

1. Have children follow the words as you read the first two lines of the story on page 114. Refer pupils to the pictures below the lines for answers to questions similar to these:

Which seed is shiny and black? flat and pale?
Where do apple seeds come from? tomato seeds?

Have children compare the fruits and the seeds in the picture with the real ones in the classroom. Ask what kind of plant apples grow on. Then ask whether tomatoes grow on trees, or on bushy plants.

2. Read the next line of the story: "The seeds were planted in the soil." Try to have the children recall the bean seeds that they planted in soil (Lesson One). These two seeds are planted the same way as the bean seeds were. Read the next line, which tells what happened to the seeds after they were planted: "They sprouted and grew into plants." Direct attention to the two young plants. Have children point to the plant that grew from the apple seed (left) and the one that grew from the tomato seed (right). **Are the two young plants alike, or are they different? Why are they different?** (Two different kinds of seeds.)

3. Read the question: Why did the plants grow? In answering this question, children will reveal their understanding of the requirements for sprouting and growing:

The seeds received water (from rain or from a sprinkler), which caused them to sprout.

The young plants continued to receive water as they grew.

The plants also received light from the Sun.

Now read the final question: **Which one became a tree?** Since there is purposely no picture to which pupils can refer, they will now have to apply their understanding of plants reproducing their own kind. If they show hesitancy in responding, guide their thinking by presenting a few additional questions about seeds and plants.

Encourage children to express their ideas freely, giving reasons for their answers. Keep the discussion open until the children show that they comprehend the idea that the environment does not change the species.

Extending the Concept

Through Activity. Buy two or three young tomato plants and raise them in large flower pots in the classroom or in an outdoor garden. Let children care for the plants and watch them grow. The dealer from whom the plants are obtained will supply instructions for the proper care in your particular climate.

Two Little Seeds

One seed came from an apple.
One seed came from a tomato.

The seeds were planted in the soil.
They sprouted and grew into plants.

Why did the plants grow?
Which one became a tree?

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LESSON 13, page 115

SUBCONCEPT: The size and structure of an organism are limited by heredity regardless of the environment.

Aim of the Lesson

To study and investigate the effects of good and poor environment on the development of hereditary characteristics, illustrated in the growth of an organism.

Introducing the Lesson

SUGGESTED: a tomato seedling (obtained from a nursery).

If a tomato plant is available, let the children examine it to become familiar with its structure. Call on individuals to come forward and show the leaves and stems. Have someone show where the roots are. Establish the fact that the plant is in good soil and is growing well. (If no plant is available, follow a similar procedure using the picture of the tomato plant on page 114.)

What do the young plants need in order to grow well?

Developing the Concept

(by emphasis on the subconcept)

1. Direct attention to the pair of pictures on the top row on page 115. Ask children to study the two pictures carefully to find out whether the two plants are the same kind. The children will recognize both plants as young ***tomato*** plants. Then ask the class why the two plants look different. Guide children's observations by presenting questions like these:

Why does one plant grow better?

In what ways does the soil look different in the two pictures?

Do both plants get equal amounts of light?

Does it seem that both plants are getting equal amounts of water?

Through comparing the two pictures, children should have no difficulty in reaching these assumptions:

> In the first picture on the left, the soil looks soft and damp, and there is plenty of sunshine. The plant in this picture looks strong.
>
> In the picture on the right, the soil looks hard, rocky, and dry and there is no Sun shining on the plant. This plant looks thin and weak.

2. Now direct attention to the middle row of pictures. Explain that the plant on the left gets plenty of water and sunlight and is free of ***weeds.*** Call on someone to describe the plant. **Is it growing well? What can now be seen on the plant?** Children will describe the many blossoms and small green tomatoes on the large, healthy plant.

Then call on children to tell what is happening to the plant on the right. They will see that this plant, too, has grown bigger than the plant just above it. By comparing it with the plant at the left, however, they will see that it has not grown well; it is still thin and weak and has few blossoms and few green fruits. This plant has been neglected. It is in a shady place, it has not been watered, and weeds are growing all around it.

3. Then have the children study the two pictures in the bottom row. Ask which plant has more tomatoes. Let the children count the ripe tomatoes on each plant and compare the numbers.

Now call on someone to read the question on the page. Through discussion of the reasons the children discover, lead them to these understandings:

> One tomato plant grows well because it is in a sunny place and in good soil. It receives plenty of water. It is kept free of weeds.
>
> The other plant grows poorly because it is in a shady place and in hard, rocky soil. It does not get enough water. Weeds are growing all around it.

Conclude the lesson by presenting a problem for discussion:

Which of the two plants has more seeds from which new plants can grow?

Children will reason that the plant that grows better produces more tomatoes and more seeds.

Extending the Concept

Through Key Concept Words. Add *tomato* and *weeds* to the Science Vocabulary Chart.

Through Investigation. If there is a green lawn in the school grounds, lay a small board on the grass where it will not be removed. Keep it there for a week or more, until the grass plants beneath it have lost their green color. After children have observed the effect on the grass of the lack of light, remove the board and have them look at the grass each day as it returns to its original green. (The spot may need some water.)

UNIT NINE: LIVING THINGS GROW

Section 6: Summary and Evaluation

CONCEPT SUMMARY
There is an interchange of matter and energy between living things and their environment. Adequate amounts of both are required for optimum growth.

LESSON 14, page 116

Aim of the Lesson

To give children an opportunity to summarize their understanding of the interaction on the development of plants and animals.

A New View of the Concept

Use the Animal ABC Book (begun in Unit Eight) or selected animal words from the Vocabulary Chart as a basis for a review. Call on individuals to explain meanings of the words. If children are able to read some of the words, let them do so. Otherwise, pronounce the words for them. Since understanding (rather than mere word recognition and definition) is desired, it may be useful to make requests: **Who can tell us something important about a *frog*? What do you know about *blue jays*? What is a *zebra* like?**

Fixing the Concept

Have children look at page 116 and read the title on the page. By now they should be familiar with the end-of-unit lessons headed THE BIG IDEA. Explain that in this check-up lesson both questions and pictures are used.

1. To illustrate, have the children look at the aquarium shown at the top of the page and then read the question beneath the picture. Explain that the big idea is to tell what the fish need in order to grow well in the aquarium. Call on someone to answer the question and explain that plants are missing. Emphasize the explanation by calling on individuals to complete this sentence: "Goldfish grow better – – – – – –." Call on others to explain why the fish grow better with plants than without plants.

2. Proceed to the second picture, and ask children to look at the geranium plant. Ask for an answer to the question. Have someone explain whether the plant in the picture is growing in light or without much light. Call on a pupil to tell how the geranium plant probably would look if it had been growing in sunlight.

Follow similar procedures with the other pictures.

3. Find the picture of the young robins. **What will the young robins be like when they are full-grown?** Call for an answer to the question. Then ask who feeds the young robins. **If there were no plants could the robins or any animals get enough food?**

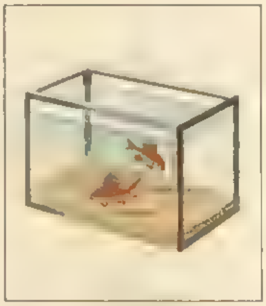
4. What kind of plant is shown in the last picture? Tell how the plant began. Do you think that something is wrong? Is the plant in the picture getting enough water? Does the plant look healthy? Is it getting enough light?

Conclude the lesson with a discussion of things plants and animals need in order to grow well. If necessary, prompt children by presenting a few challenging questions about food, water, sunlight, warmth, etc. As an animal's need for plants is mentioned, help children to recall that without plants there would eventually be no food for animals nor would there be food anywhere around us.

Extending the Concept

Through a Field Trip. If possible, take the children on a short trip around the neighborhood where they can see many plants (weeds, grasses, etc.). Note that some are growing well in good soil and in good light; others are drying up because of lack of water and for lack of sunshine. Perhaps you can discover worms that have crawled away from a moist place and are drying up. Anything that will help to reinforce the Big Idea of the unit may be noted during the trip.

Through Story Books. Have the children discover characteristics of animals or plants in certain environments. If they cannot identify the animals by names, have them describe the animals or plants. For example, snakes in warm or sunny places; scraggly plants and lizards in deserts; big-leaved plants in hot climates; no trees on snowy slopes.



Is something missing?

Is something wrong?

THE BIG IDEA

What do the robins need?

Is something wrong?

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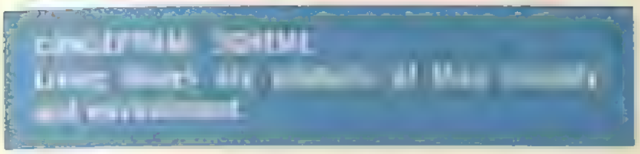
UNIT TEN: WE GROW



Children are interested in evidence of their own growth and development. They are eager to be recognized as "big boys" and "big girls." They relish the fact that they are no longer babies. Many of them eye with admiration the developing muscles and superior prowess of older children and strive to emulate them.

Ordinarily, young children are not conscious of health habits. They either go to bed early or stay up for the late show, either eat nutritious foods or fill up on candy-store sweets, and are either clean and neat or untidy according to customs and facilities in their respective homes. It is important to remember always that some children have little opportunity to learn good health practices at home and that it takes time and effort to develop good habits.

Gradually, however, all children's horizons broaden and choices become available to them. Experiences in school, as early as the first grade, can be used to help boys and girls become aware of the importance of proper food, fresh air, exercise, adequate sleep, and cleanliness.

The Conceptual Scheme is the same as for Units Seven and Eight. The subconcept in Unit Ten is as follows: There is an interchange of matter and energy between living things and environment.

Food, Energy, and Growth. Food is the fuel used by the human body. As the food is oxidized in the body, energy is released. The energy is used to move the body and also for the specialized work done by the heart, glands, and other internal parts. Some of the energy yielded by the oxidation of food is in the form of heat — heat that maintains a fairly constant body temperature (normal, 98.6° F) regardless of changes in the temperature of the environment.

In addition to supplying energy, food builds and repairs body tissues. Cells multiply, and bones and muscles grow as children progress toward adulthood. At the same time, the body, using elements from food, is able to heal wounds, knit broken bones, and repair other damages caused by infection or accident.

Human beings need water. While we can, if need be, survive many days without food, we cannot go more than a few days without water.

Oxygen and Fresh Air. We can survive only a few minutes without air. Man, like all lung-breathers, is completely dependent on air from the atmosphere. Oxygen, one of the gases of which air is composed, is used in the essential process of oxidizing food. As we inhale and exhale, we are repeatedly removing oxygen from the air and adding carbon dioxide to it.

Continuous inhaling and exhaling in a small, confined area can soon deplete the supply of oxygen from the air. *Young children are to be warned of the extreme danger of playing in small closets, cupboards, trunks, and especially in old refrigerators.*

Food for Nutrition. For strong bones and muscles, sound teeth, healthy skin and blood, and abundant energy, children are dependent on good nutrition. Malnutrition, caused by not eating enough or by eating the wrong kinds of foods, results in a wide variety of physical deficiencies, some of which may never be outgrown.

Nutrition specialists have devised a number of food plans as guides for adequate daily diet. The plans that are best known are called the *Basic Seven* or the *Basic Four*, listing essential food groups as follows:

1. Leafy vegetables; other green vegetables; yellow vegetables.
2. Citrus fruits; tomatoes; raw cabbage; salad greens.
3. Potatoes; other vegetables and fruits not included in groups 1 and 2.
4. Milk and milk products.
5. Meat; poultry; fish; eggs; dried beans and peas; nuts.
6. Bread; flour; cereals.
7. Butter or fortified margerine.

Many nutritionists recommend that at least one serving of food from each of the food groups be eaten every day.

UNIT TEN: WE GROW

Section 1: Growth of a Child

CONCEPT
There is an interchange of matter and energy between living things and their environment. Adequate amounts of both are required for optimum growth.

LESSON 1, pages 118 and 119

SUBCONCEPT: The size and structure of an organism is determined by the interaction of heredity and environment.

Aim of the Lesson

To emphasize the importance of food, air, and sleep in promoting growth.

Introducing the Lesson

Take the class to watch a class of fifth- or sixth-grade children engaged in baseball or some other active game. Make the observation period a short one, just long enough for the younger children to see some of the things the big boys or girls are able to do in physical education. Then arrange to have silhouettes of an upper-grade boy and girl tacked or taped to the front wall in your classroom, so that the first graders can compare their heights and shoulder widths with those of the older children. If silhouettes are not feasible, make chalk marks on the board for heights and shoulder widths.

Lead into the lesson with this question:

What are some of the things first-graders must do to help them grow bigger and stronger?

Developing the Concept

(by emphasis on the subconcept)

1. Have children look at the picture on page 118 to find out what the big boys are doing. First-graders will be able to identify the game as baseball.

Call attention to the smaller boy and ask why he is not playing baseball. Pupils will realize that he is too young; he is not yet big enough to play on the team.

At this point, announce that the boy's name is Greg. Write *Greg* on the board, and then have children find the word in the title of the story. Have someone read the title.

Next, have a child read the first line. Have those children who are six years old, hold up their hands. Draw attention to the idea that Greg is the same age as those children who held up their hands.

Now choose a child to read the next sentence. As the big brother is referred to, you may wish to call for another show of hands, this time from all the children who have brothers in grades 4 to 6. Then continue with the third line to find out what Greg is doing in the picture. Certainly some members of the class will be eager to tell about athletic activities in which their brothers engage.

Now call on different children to read the last three lines in sequence. If your pupils are able to read independently, they may read the entire story to themselves. Otherwise, you may wish to read it over to them.

Initiate a brief discussion of the story by presenting a few questions:

What is Greg doing in the picture?
Why does Greg want to grow bigger?
Why does he want to grow stronger?
Do you think that Greg *will* grow to be as big and strong as his brother?

2. Now, as a lead to page 119, present a further question to the student:

What are some of the things Greg must do to help himself to grow big and strong?

The pictures on page 119 show Greg doing certain things that help him to grow and to be healthy and strong. Call on someone to describe what Greg is doing in the top picture on the left. In this lesson, the point to be stressed is that Greg is eating; he is taking in *food*. The specific kinds of food need not be identified.

3. Have the class study the next picture on the right to find out what the boy is doing. Ask whether Greg is playing indoors or outdoors where there is plenty of ***fresh air.*** Develop the idea that Greg is getting ***exercise.***

4. In the last picture children see that the boy is getting ***sleep;*** also, he is getting fresh air through an open window in his room.

Greg and His Brother

Greg is six years old.
His brother is big and strong.
Greg watches his brother play baseball.
Greg wants to be big and strong.
He wants to be like his brother.

After the children have discussed the pictures one at a time, ask them to look again at all the pictures and tell some things that Greg is doing to help him grow. Prompt children, if necessary, until they realize that proper food, exercise, fresh air, and sleep are conducive to good growth and health.

Explain that everyone needs these things if he or she is to stay healthy. Boys and girls need them for growth as well as health.

Direct attention to the pictures on pages 118 and 119 as you present some problems for thought and discussion:

Do you think that Greg's brother gets plenty of food, exercise, sleep, and fresh air? Why do you think so?

Suppose that Greg does the things shown on page 119 except that he doesn't eat well. **Do you think then that he will grow to be as big and strong as his brother? If he does any three of the four things shown, but omits the fourth?**

Children will show their understanding of the main points of the lesson by asserting that Greg's strong, baseball-playing brother probably gets the things he needs in order to grow well. They will realize that Greg must eat well, exercise, and get plenty of sleep and fresh air if he expects to grow to be as big and strong as his brother.

Extending the Concept

Through Investigation. Let each child make a picture of one of his own hands by spreading a hand flat on a small sheet of paper and drawing around it. Get similar drawings from a sixth grade class, and use them as a frieze, where children can compare hand sizes, contrasting the sizes of their hands with those of the older children.

119

Through Activity. Encourage children to bring in pictures of older boys and girls engaged in active sports. The pictures may be cut from magazines. Use the pictures for a chart or bulletin board display on "Big and Strong."

Suggest that some children bring in baby shoes. Let the children compare the shoes they are wearing with the tiny shoes they wore when they were babies. They may be surprised to see how much their feet have grown. Baby socks may also be used for a similar comparison.

Ask children to bring in snapshots or photographs of themselves as infants. Use the pictures, with children's names attached, for a bulletin board display headed, "We were little. Now we are bigger." If it is not practical to have children lend their own pictures for the display, baby pictures cut from magazines may be used.

Collect materials for an exhibit on keeping clean. Use such items as soap, wash cloth, nail brush, nail file, orangewood stick, shampoo, hair brush, comb, cleansing tissues, etc. Call on children to show or explain what each of the items is used for.

Provide a number of small mirrors for the children, and let them look at their front teeth. Explain that these are "first" teeth or "baby" teeth. They will be pushed out, one by one, by larger "grown-up" (or permanent) teeth. If any child has already lost a baby tooth (and is *proud* of it), he may be willing to show the permanent tooth that is starting to grow. Explain that it is important to keep the baby teeth in good condition even though they come out. They must be strong and whole to keep proper places for the permanent teeth which follow.

Through Key Concept Words. Begin a *Health Words Column* in the Science Vocabulary Chart. Start with *food* (a review word from earlier units), *fresh air, exercise,* and *sleep.*

LESSON 2, pages 120 and 121

SUBCONCEPT: Food (matter and energy) is essential to the survival of an organism.

Aim of the Lesson

To help children to become aware of the importance of the kinds of foods they eat.

Introducing the Lesson

Allow children a few minutes to tell about some of the foods they *like* to eat for breakfast. (NOTE: If the class is from a homogeneous neighborhood, the eating habits of the children probably will be quite similar. However, if the neighborhood is heterogeneous, the children's eating habits will vary greatly. In any case, it may be inadvisable to ask them to account for what they have to eat at home. Their food preferences will serve to give you some insight into the general nutrition situation in the class.)

If any seriously inadequate breakfasts are suggested, make a note to discuss the matter with the school nurse or medical advisor. Accept all the children's offerings without comment or class evaluation, and then lead into the lesson with a question:

What are some of the foods we should eat every day in order to grow big and strong?

Developing the Concept

(by emphasis on the subconcept)

SUGGESTED: a slice of white bread and a slice of whole wheat bread.

Have the children look at all the pictures on pages 120 and 121. Call on individuals to report on what is shown as a complete picture (many good things to eat). Do not go into specifics at this stage.

1. Direct attention to the picture at the top of page 120 and to the caption below the picture. Write ***breakfast*** on the board, and then have the class find that word under the picture. Call on someone to read, "A good breakfast."

Next, choose individuals to describe a food that is part of the good breakfast. Use the picture as a guide, but try to get the children to suggest and discuss several good alternatives in each case. Below are a few of many possibilities:

Milk, chocolate milk, cocoa made with milk.

Orange juice, tomato juice, pineapple juice, stewed fruit, half a grapefruit, or other kind of fresh fruit.

Oatmeal or other cooked cereal, dry cereal or bread.

Egg, poached or scrambled, or soft-boiled.

Meat (although not shown, some kinds may be mentioned along with eggs).

Toast or roll with butter, jelly, or jam.

As toast is discussed (shown under the poached egg in the picture), call attention to the color of it. If you have two slices of bread, as suggested above, pass them around and let children see the difference between white and whole wheat bread. Explain that both kinds are good foods and will help children to grow big and strong.

2. Now direct attention to the picture on the bottom of page 120. Write ***lunch*** on the board, and then help the class to read the words under the picture. Ask where this particular lunch might be eaten. Children will see from the picture that the lunch was packed in a kit and will assume that it is to be eaten at school or at a picnic.

Let children pick out the separate foods and tell about each kind. Here again you may wish to discuss possible alternatives for the foods that are shown:

Peanut butter sandwich and meat sandwich or sandwiches with egg, tuna fish, jelly, etc.

Carrots and celery, or other sliced or whole vegetables, as tomato, green pepper, lettuce, onions, radishes, or cucumbers.

Apple and banana, or other fruits.

Cookies, graham crackers, plain cake, raisins, or nuts.

Milk, or milk drink of some sort.

Call attention to the two kinds of bread used for the sandwiches.

3. Now have the class look at the picture at the top of page 121 as you write ***dinner*** on the board. Call on someone to read the words under the picture. You may find it desirable to explain that, in some families, the meal that is eaten in the middle of the day is dinner, instead of lunch. Then the evening meal is called *supper.* Dinner is usually the main or largest meal, regardless of when it is eaten.

Call on individuals to describe the separate foods that make up a good dinner, as shown in the textbook. If time permits, you may wish to discuss alternatives to each of the foods pictured:

Tomato juice, fruit juice, fresh or canned fruit, or soup.

Hamburger, or other kind of meat, fish, fowl, eggs, or cheese.

Potato, baked, or fixed in another way, spaghetti, noodles, or dried beans.

A good breakfast

A good lunch

120

Spinach, fresh peas or beans, or other cooked vegetable.

Green salad or cole slaw, or other kind of salad, or raw vegetables.

Fruit and cookie, pudding, or other simple dessert.

Milk, or some kind of milk drink.

Have children look back over the breakfast, lunch, and dinner foods to see that milk is included at each meal.

4. Then direct attention to the picture at the bottom of the page, where another serving of milk is shown, and explain that all these pictures show some foods, *one* or *two* of which may sometimes be eaten between meals — after school, for instance, or perhaps for a bedtime snack. The amount eaten for a snack should be limited. Instead of discussing each of these foods in detail, let the children find some of their favorites, and then call on them to respond to questions like the following:

What are some good things to drink when you are thirsty between meals?

What are some good things to spread on bread when you get home from school and feel hungry?

What food is sweet and chewy? (raisins)

What food is crunchy when you chew it? (peanuts)

What are some good tasting fruits?

Which of the things in the picture might you bring to school in your lunch? (any of them, including milk in a vacuum bottle)

Now ask: **Why do you need food? What does food do for you?** For meaningful answers, call on children to read the two sentences at the bottom of the page.

Thus far, the emphasis has been on foods that are good for children and that also appeal to most children. It is quite probable, however, that during the lesson some children may have mentioned other kinds of foods: popsicles, cola drinks, candy bars, gum, etc. There is some food value to nearly all of these things. However, explain that children who eat and drink a considerable amount of such "sweets" are likely *not* to have an appetite for the foods they must have for good growth — foods like those shown in the textbook for breakfast, lunch, dinner, and treats.

By the close of the lesson, children should be able to express the following assumptions in their own words:

> We need three good meals a day: in the morning, at noon, and at night.
>
> At our meals and for extra treats, we should eat foods that give us energy and help us grow — foods that are good for us.
>
> Without good foods, we cannot grow big and strong.

Extending the Concept

Through Art. Let each child choose his favorite meal (breakfast, lunch, or dinner) and make a picture of the things that he or she thinks are good to eat at that meal. By discussing a picture with the child who made it, you will be able to evaluate that child's individual understanding of the lesson and knowledge of good foods.

Through Key Concept Words. Add *breakfast, lunch, dinner* to the Science Vocabulary Chart.

A good dinner

Extra treats

Food gives you energy.

Food helps you grow.

UNIT TEN: WE GROW

Section 2: Weight and Height of First-Grade Children

CONCEPT
There is an interchange of matter and energy between living things and their environment. Adequate amounts of both are required for optimum growth.

LESSON 3, page 122

SUBCONCEPT: The size and structure of an organism is determined by heredity and environment.

Aim of the Lesson

To help children to become aware of weight increases.

Introducing the Lesson

REQUIRED: a bathroom scale.

Show the scale to the class and ask what it is used for. Then have a boy and a girl of about average size come forward. Weigh them and write their weights on the board. Explain that some first-grade children weigh more and some less than the weights written on the board. Lead into the lesson with this question:

How much more do you weigh now than when you were born?

Developing the Concept
(by emphasis on the subconcept)

REQUIRED: a bathroom scale or the use of a weighing scale in the office of the school nurse.

1. Ask the children to look at the picture at the top of page 122. Call on someone to tell what is being done in the picture. Ask why the baby is not standing on a scale like the one in the classroom. Through discussion, develop the idea that the baby is only a few days old. The baby is not strong enough to sit up or stand by itself.

Call attention to the scale and the indicator that shows how many pounds the baby weighs. Suggest to the children that this baby weighs seven pounds.

Write 7 on the board, and let the children compare this weight with the weights of the boy and girl who were weighed previously. (Help them to discover that the weight of the boy or girl is about 3 tens more than that of the baby. For example, 36 is $10+10+10+6$.)

2. Next, direct attention to the picture at the bottom of the page. Ask what is happening to these first-grade children.

Call on a child to read the question on the page. It is unlikely that many first-grade children will know their weight, so ask what should be done to find the answers to the question. If children seem interested in being weighed, arrange to have this done. (It may be preferable to have the members of the class weighed in the nurse's office.)

If the weighing is done in the classroom, you will probably need to assist pupils in reading their weight correctly. Write each child's name and weight (to the nearest half-pound) on a slip of paper and give it to him.

Summarize the weighing experience by reviewing the picture at the top of the page. This will strengthen the children's awareness of the many pounds they have gained since they were born. Develop the following understandings:

We weighed only a few pounds when we were born.
Now we weigh many pounds more.
We are getting heavier as we grow up, or get older.

Check children's understanding of weight increase by presenting a few questions for discussion:

When you were in the kindergarten, do you think that you weighed more or less than you do now?

By the time you are in the third grade, do you think that you will weigh more or less than you do now?

Extending the Lesson

Through Activity. Make a class weight and height chart. (CAUTION: If there are extremes of weight or height in the class, it may be well to avoid this activity.) List the children's names alphabetically, and beside the names draw two columns. Record the weight in the first column and leave the second column for the height. The total span for each sex should be small. If a weight chart was used in connection with the study of gravity, add the present weight and let children note their weight gains during the school year.

How much do you weigh now?

LESSON 4, page 123

SUBCONCEPT: The size and structure of an organism is determined by heredity and environment.

Aim of the Lesson

To help children to become aware of height changes.

Introducing the Lesson

REQUIRED: a yardstick or tape measure and several rulers.

Choose a child (of average height) to come forward. Have him stand against the wall, and then place a ruler across the top of his head. Have a second child hold the end of the ruler against the wall while you use the yardstick or tape measure to determine the distance from the floor to the ruler in inches. Write the number of inches on the board, explaining that the child is *that many* inches tall. Pass the rulers around and let all children find 1 inch, 2 inches, 12 inches. Show the yardstick or tape measure, and explain how you used it to find the child's height. Then present this question:

How tall are the boys and girls of our class?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: a yardstick and the use of the measuring rod on the weighing scale in the office of the school nurse.

1. Direct attention to the picture at the top of page 123, and call on someone to describe it. Tell the children that the baby is 20 inches tall, or long. Then show the baby's real height on the yardstick. Draw a line 20 inches long on the board or rough outline of a baby. Explain that most babies measure about 20 inches when they are born. Encourage children to wonder that they were once so little.

2. Then have the class study the picture on the bottom of the page to see what the boys and girls are doing. The pupils will report that they are being measured to find out how tall they are.

Call on someone to read the question at the bottom of the page. Ask children whether they would like to find out how tall they are and how many inches they have grown since they were babies. If you get affirmative answers, announce that the measuring will be done later in the nurse's office. (However, you may prefer to measure the children in the classroom, following the procedure suggested in the first investigation below.)

Emphasize the idea that all of the children have grown a great deal since they were born . . . grown in both weight and height. Then present the following question for discussion: **What are some of the things children need to do to help them keep on growing well?** The answers will help to bring out these understandings:

We need to eat three good meals every day.

We need to get plenty of exercise.

We need to play outdoors in the fresh air and sunshine.

We need plenty of sleep at night.

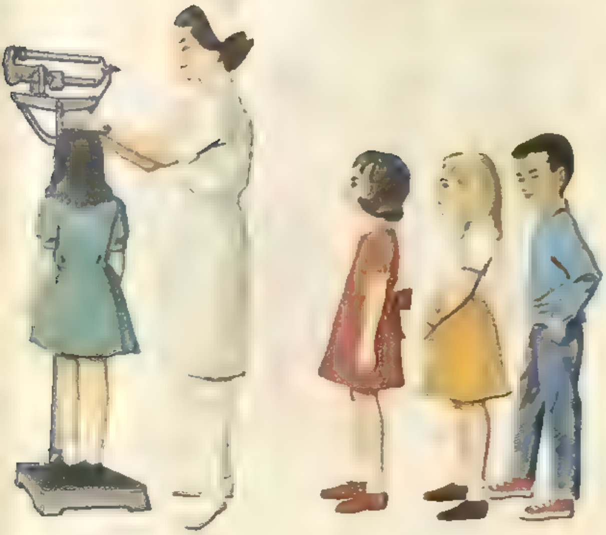
Explain that these four things will not only help the children grow well, but will also help to keep them healthy. They will find out more about keeping healthy in later lessons of this unit.

Extending the Concept

Through Investigation. Make a class *measuring* chart by fastening a long strip of tag board to the wall. Mark off inches on the strip. Cut out a rough silhouette of a baby, 20 inches high, and fasten it to the bottom of the chart. Then measure each child by having him stand against the chart while you make pencil marks for his height, determined by holding a ruler level across the top of his head. Write children's names or initials beside the lines that indicate their respective heights. Children will enjoy noting how much taller they are than their 20-inch baby height.

Through Investigation. Use the same chart to measure a sixth grade boy and girl of average height to show how many more inches the first-graders may expect to grow by the time they become sixth-graders. If the chart is tall enough, also measure the height of one or two teachers to show a complete height span.

Through Activity. Complete the weight and height chart suggested at the end of Lesson 3. If the children assist with the measuring in the classroom and see how tall they are as shown on the class measuring chart, they will be interested in transferring the heights to the other chart. Of course, more accurate heights may be obtained by the school nurse, but the pupil interest may wane.



How tall are you now?

LESSON 5, pages 124 and 125

SUBCONCEPT: The size and structure of an organism is determined by heredity and environment.

Aim of the Lesson

To help children become aware of the normal difference in rate of growth.

Introducing the Lesson

Initiate a discussion of some of the ways in which the children in the class are alike and some of the ways in which they are different. **Are all in the same grade? Are all six years old? Do some have light hair? Do some have dark hair? Are some taller than others? Do some weigh more than others?**

After children have agreed that there are many differences among them, lead into the lesson with this question:

Since we are all in the same grade, why aren't we all the same size?

Developing the Concept

(by emphasis on the subconcept)

1. Have the children look at the pictures on pages 124 and 125. The boys and girls are using a *walk-on-number line* which is useful in teaching arithmetic. Call on someone to count the number of boys shown on one page and the number of girls shown on the other page. Ask whether all the boys look alike; all the girls. Are some boys bigger than others? Are some girls? For each picture have pupils put their fingers on the tallest child, the shortest child, and the one who apparently weighs the most.

Ask whether these children, who are different in size, are all in the same grade. For an answer, have someone read the first line on page 124. Through a few comments, help children to be aware of the fact that the children in the pictures, like the ones in the classroom, differ in size. (As mentioned in Lesson 3 it is well to be cautious about comparisons that may embarrass exceptionally large or small children, who may be sensitive about their size. The idea of the lesson is to reassure children about the variations in size, rather than to make any feel conspicuous.)

Next, call on a child to read the second line. Compare the age of the children in the picture with the ages of the children in the classroom. You may wish at this point to select five boys and five girls (six-year-olds) to come to the front of the room and line up like the children in the picture.

Then have someone read the third and fourth sentences on page 124. The pupils will see that the children in the classroom, like those in the pictures, vary in size and in looks. Before reading the lines on the next page, try a few questions:

Why are some boys and girls tall and some short?

Why do some weigh more than others?

Are some of them not growing?

2. For answers, direct the children to the sentences on page 125. Call on someone to read the first sentence. Ask pupils how they know that the boys and girls in the pictures have grown since they were babies. Through discussion, help them to recall that each child was once very tiny (about 20 inches long, and about 7 pounds in weight). Each has grown a great deal since then.

Choose a child to read the second sentence. Then call on children to describe a boy and a girl who, in the pictures, seem to be growing fast.

Have someone read the third sentence, and then let children find pictures of boys and girls who seem to be growing more slowly.

Read the last sentence to the class, and explain it fully. Different children grow at different times; some shoot up early, while others grow very slowly for several years and then shoot up. The bones and muscles of some children are bigger than those of other children. Some children are naturally stocky and heavy, and others are naturally thin and light. We are all different.

Let children speculate as to what the class would be like if everybody looked the same. How confusing and uninteresting it would be if all our friends were alike! We could not tell one person from another.

To help determine the children's comprehension of the lesson, ask them to think of reasons *why* children are not all alike. If necessary, stimulate responses with a few questions like the following:

Is there anyone in the world who looks exactly like you?

Do you look something like your parents or other relatives?

Why do brothers and sisters often look somewhat alike?

Through discussion, help children to reach the following assumptions, expressed in their own words:

We are all different.

We are different because we have different parents. We are from different families.

We are all in the first grade.

We are the same in some ways.

We are different in some ways.

We do not look alike.

Brothers and sisters are more alike because they have the same parents.

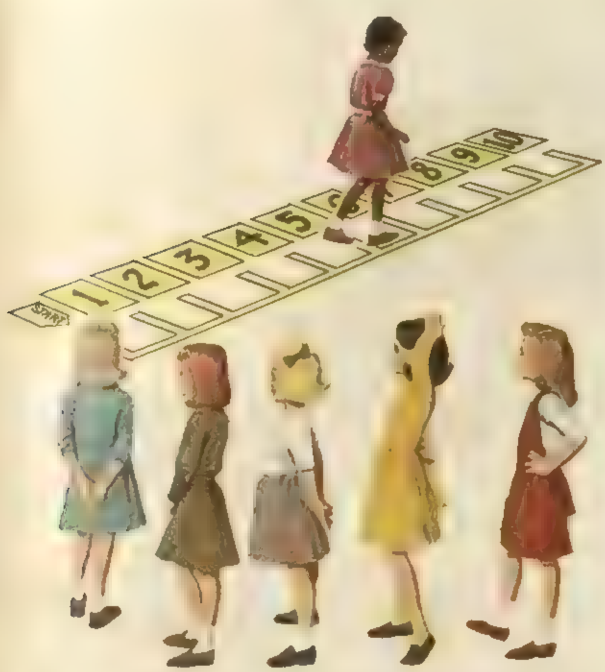
We are all growing; some grow slowly and some fast.

Extending the Concept

Through Investigation. If you have any left-handed children, this may be a good time to explain that left handedness is natural for some persons. It is just as good as right handedness. However, there are fewer persons who are left-handed. Give special attention to the seating, lighting, and placement of paper for written work for left-handed children.

Through Art. Give the children large sheets of paper and ask them to make pictures of themselves with one parent. Suggest that each child show the parent he most closely resembles. The portraits that result are delightful additions to the classroom, especially when parents visit.

Through Following Up an Investigation. If any of the children seem to you to be seriously underweight or overweight, discuss the matter with the school medical authority. Assistance or guidance may be available for such children and their families.



We are not all the same size.

Some of us grow fast.

Some of us grow more slowly.

We all grow differently.

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UNIT TEN: WE GROW

Section 3: Summary and Evaluation

CONCEPT SUMMARY
There is an interchange of matter and energy between living things and the environment. Adequate amounts of both are required for optimum growth.

LESSON 6, page 126

Aim of the Lesson

To give children an opportunity to apply to several situations their understanding of the effects of environment on health and growth.

A New View of the Concept

Present the health part of the Science Vocabulary Chart and review the words orally: *food, fresh air, exercise, sleep, breakfast, lunch, dinner*. As you read each, call on a child to tell something about the word that indicates understanding — something that has to do with keeping well and growing strong.

Fixing the Concept

Call on a volunteer to read the title of page 126 and explain the kind of lesson that is on the page. From experiences throughout the school year, children should be familiar now with THE BIG IDEA lessons.

Begin by reading the question at the bottom of the page. Then explain that in each row of pictures, one picture shows something that helps children to grow strong and keep well and the other picture shows something that may be interesting or entertaining but does not contribute to good health.

Refer to the pictures by rows, and then call on individuals to answer some pertinent questions.

Row 1. **Which is more healthful, to sit in the dark watching a movie or to play outside? Why?** (Guide children to mention sunshine, fresh air, and exercise.)

Row 2. **Which are more healthful, the foods in the right-hand picture or those on the left? What may happen to your regular eating habits if you eat too much of the food shown in the second picture? What are some good foods to drink when you are thirsty?**

Row 3. **Who can tell what time it is in both pictures? Which is more healthful, to be listening to the radio at ten o'clock at night or to be asleep at that time? Why should first-grade children be asleep by ten o'clock?**

You may wish to discuss other good health practices, including cleanliness, and then help the children to compose a simplified set of rules for good health. Guide the children toward short rules that are general and inclusive. The list below is offered as a suggestion:

Keep clean; play outdoors; eat the right foods; get enough sleep.

Check children's understanding of good health practices by presenting questions about the good health rules:

If you do not follow good health rules regularly, what may happen?

If you do follow the rules regularly, what do you think will happen?

Pupils will respond that unless they keep clean and have enough food, fresh air, sleep and exercise, they cannot grow well or stay healthy. With enough of each of these things, children will grow big and strong and will keep well.

If children have composed a few rules for good health and growth (as suggested above), make a separate chart for each rule. Have children collect pictures, or make some original ones, to illustrate each chart. Use the charts as a basis for reviewing children's health practices.

You may find it advisable to explain the proper use of the school's sanitary facilities. Many children seem to act as though the place to discard rubbish and generally create a messy appearance is the lavatory. With the assistance of another teacher, take the girls and the boys to their respective lavatories. Show the children the proper way to use the various facilities, when and how to wash their hands, how to dry them well with one paper towel, and where to dispose of the towel. Then give any other suggestions that may seem needed for children's hygiene and for the maintenance of clean, orderly lavatories.

THE BIG IDEA

Which is more healthful?

126

UNIT ELEVEN: LONG, LONG AGO

CONCEPTUAL SCHEME
Organisms have changed over the ages.

Children often know about dinosuars before they enter the first grade, though their knowledge may be more fantasy than fact. Often they have been exposed to comic strips, motion pictures, and television programs that incorrectly show cave men and dinosaurs either fighting with each other or living together in domestic tranquillity. It is sometimes difficult to convince young children that there were no people on earth until long after the dinosaurs had disappeared completely.

It is not feasible to try to develop any accurate concept of historical time for the first-grade pupil. Many years ago, thousands of years ago, or millions of years ago can be expressed satisfactorily by him and for him as "long, long ago." Perhaps it is the somewhat mysterious aspect of the long ago that makes the study of prehistoric animals so fascinating to children.

The long history of plants and animals is recorded in the Earth's crust. Any impression or trace of a plant or animal that has been preserved in the Earth's crust is called a fossil. Fossils vary from those of small plants to those of giant dinosaurs. The fossils tell of life on our planet before the time of man. From fossil evidence we know with certainty that both plants and animals have changed over the years.

Certain plants and animals flourished during one period of the Earth's history only to disappear completely during the next. Others came into being in the long-ago past, survived, changing gradually as the environment changed, and are still flourishing today. It is important here to present the idea of change during past ages and to suggest that life on the Earth is still changing.

The subconcept in Unit Eleven is: "Animals of the past were different from animals of the present."

Animals of the Past. Life may have existed some 2 billion years ago, but those animals which left fossils became abundant only about 500 million years ago. The earliest of these were animals without backbones (invertebrates) that inhabited the waters of prehistoric seas.

Then came the vertebrates; they appeared about 420 million years ago. They were fish, and breathed through gills. Gradually, as the fish changed through many generations, some species developed lungs. Their fins became strengthened by muscle and bone, permitting a kind of walking about. Scientists believe that these species were the ancestors of the first land animals, the amphibians.

Reptiles, which followed amphibians (a long time after), were equipped for full-time life on land. For nearly 150 million years the Earth was dominated by reptiles, particularly by the species known as the dinosaurs.

The first birds appeared about the middle of the dinosaur period. They were the first warm-blooded animals.

The first mammals appeared about the time the dinosaur began to disappear, perhaps 165 million years ago.

Why Some Animals Become Extinct. The many kinds of dinosaurs, the great mammoths, and the predatory sabertooth, as well as a host of other animals of the past, died out. One reason that animals become extinct is a change in environment to which those animals do not adapt.

Becoming extinct, by any species, from whatever cause — temperature, food, disease, predators, etc. — was usually a slow process, extending over millions of years.

Fossils. When a plant or animal dies, its soft parts are usually eaten by animals, or they decay and disappear. Under certain conditions as when burial occurs quickly or when air and moisture are excluded, the hard parts of living things — wood, bone, teeth, shell — are preserved. In rare instances a whole animal is preserved in tar or in a continuously frozen state. Sometimes impressions of living things are made in mud or clay which later changes to rock.

Fossils are studied by scientists (paleontologists) concerned with evidence of life in the past. These persons assemble fossil bones into complete skeletons from which the size, shape, and many of the characteristics of the original animals may be determined. Sometimes complete reconstructions of extinct animals are made.

UNIT ELEVEN: LONG, LONG AGO

Section 1: Dinosaurs

CONCEPT
Animals of the past were different from the animals of the present.

LESSON 1, pages 128 and 129

SUBCONCEPT: Life in the past is reconstructed from fossil remains.

Aim of the Lesson

To introduce children to a prehistoric period; the time of the dinosaurs is used as an example.

Introducing the Lesson

NOTE: This lesson is an introduction leading to the idea of fossils as a source of evidence for the existence of prehistoric life.

Write *lizard* on the board and through discussion (or by turning back to Unit Eight) recall that a lizard is a reptile. If children are familiar with lizards, encourage them to tell some of the things they know about lizards. If lizards are relatively uncommon in your area, explain that different kinds of lizards are found in many parts of our country, including a poisonous kind called a Gila monster. Add that long, long ago — longer than the children can even think about — strange animals that were something like giant lizards lived on our Earth. Lead into the lesson with:

What were these strange animals that lived long, long ago?

1. Have children look at the pictures on pages 128 and 129. Many pupils will eagerly identify the animals as dinosaurs. Write ***dinosaurs*** on the board and have the class pronounce the word.

Perhaps you can get some children to tell what they know (or think they know) about dinosaurs. Express appreciation for the information or misinformation that the children contribute, but do not discuss or contradict it. Then tell the class that everyone will now have a chance to find out some things about dinosaurs — what they were really like and how they lived.

2. Have the children follow the words on page 128 as you read the title and the six sentences of the story aloud to them. If there are children in the class who are capable readers, you may prefer to call on them to read the story aloud while other members of the class listen. In either case, the emphasis here is on reading for information and interest. If necessary for the children's understanding of the story, write ***swamp*** on the board and explain its meaning.

After this part of the story has been read aloud once or twice, refer children once more to the pictures on pages 128 and 129, then call on volunteers to describe what the land was like on our Earth in those long-ago times. **How was it different from what we see today?**

Through discussion, help children to be aware of these differences:

The temperature and humidity were high.

There were different kinds of trees and other plants.

There were different kinds of animals.

There were no people.

3. Now continue the story by reading the sentences on page 129. This part tells them more about some of the strange animals of the past. (There were many other and smaller animals living in and out of the water, but the dinosaurs dominated the scene.)

After this second part of the story has been read, encourage children to discuss its contents by asking the following questions:

In what way do you think that the animals in the pictures look like lizards? In what way are they not like lizards?

What general name is given to lizards, turtles, and snakes? If dinosaurs belong to the same class (reptiles) of animals as lizards, what may they also be called?

Where could you go to see a live lizard? Where could you go to see a live dinosaur? Did any person ever see a live dinosaur?

You have seen that there are some differences (as size) between a dinosaur and a lizard, but can you now think of

Something Like a Lizard

Long, long ago, the Earth was different.

It was very warm.

There were big swamps.

There were big forests of strange trees.

Strange animals lived on the land.

Some lived in the swamps.

another important difference? (Dinosaurs are no longer living.)

By now, someone is almost certain to have asked, **"How do we know about dinosaurs?"** This is a good question. Explain that everyone will have a chance to find out about "how we know" later in the study of dinosaurs.

4. Encourage questions and discussion among the children to reinforce their comprehension of the following generalizations:

Long, long ago, things on our Earth were very different from the way they are now.

There were different kinds of plants and different kinds of animals.

Dinosaurs were on the Earth then.

There are no dinosaurs alive today. They have been gone for a long, long time.

Extending the Concept

Through Activity. Suggest that children bring in models of prehistoric animals. Plastic models are often available in sets in toy stores and in dime stores. Highly accurate models that are made carefully to scale are sold at various museums.

Through Key Concept Words. Add *dinosaur* and *swamp* to the Science Vocabulary Chart.

Through Library Research. Make available a variety of books containing authentic pictures of various kinds of dinosaurs. Encourage children to consult the books to discover the many kinds of dinosaurs, how they looked, and in what kinds of surroundings they lived.

Through A Field Trip. If possible, arrange a museum trip.

Some of the animals looked like
giant lizards.
They were dinosaurs.
A dinosaur was a kind of reptile.
There are no dinosaurs alive today.
They died out long, long ago.

LESSON 2, page 130

SUBCONCEPT: Life in the past is reconstructed from fossil remains.

Aim of the Lesson

To introduce children to different kinds of dinosaurs.

Introduction to the Lesson

Lead the class into a discussion of what they have learned about dinosaurs and the environment in which dinosaurs lived. Call on several children to tell what a dinosaur looked like. If the children have used the books mentioned at the end of Lesson 1, they may give several different descriptions. Then lead into the lesson with this question:

What were some of the differences among dinosaurs?

Developing the Concept

(by emphasis on the subconcept)

As children first look at page 128, allow them time to enjoy the pictures of the strange looking animals and to talk about what they see. Then call attention to the story beneath the picture.

Call for volunteers to read each sentence before it is discussed, giving assistance with words as needed. You may wish to read each sentence aloud as children follow the words. If the children have to struggle with a number of unfamiliar words, they may lose track of the essence of the story.

Below are suggested some comments and questions of the type you may wish to use after the reading of each sentence.

Sentence 1. In Unit Nine, page 110, you saw how big a whale is as compared to several other living animals. (This may be a good place to review the pictures on page 110.) Can you imagine an animal with legs that is nearly as big as a whale? Just think of an animal about as big as two classrooms walking around the playground. (If you wish to *pace off* about thirty long steps in the school yard, you can illustrate the length of one of the giant dinosaurs. The largest ones were nearly 90 feet in length.)

Sentence 2. Have each child show with his hands the length of a full-grown chicken from its beak to the end of its tail. Some dinosaurs were only about as big as an ordinary chicken. Use a yardstick to illustrate the length of a small dinosaur (about 2 feet).

Sentences 3 and 4. Find the picture in the textbook of the dinosaur with a mouth like a duck's bill. In what way do the dinosaur's feet look like a duck's feet? This kind of dinosaur used its webbed feet for swimming. It used its duckbill mouth for scooping up plants out of the water. It is sometimes called a *duck-billed dinosaur.*

Sentence 5. Find the picture of a dinosaur with ***horns*** on its head. It is called a *horned dinosaur.* **How do you think it used its horns?** If the children do not know the answer, have them turn back to page 129 to discover that the dinosaur is using its horns to fight with another dinosaur. What live animals can you think of that have horns for protecting themselves?

Sentence 6. Find the dinosaur with a row of hard ***plates*** on its back. This kind is called a *plated dinosaur.* **In what way do you think the big, hard plates may have been useful to the dinosaur? Would it be easy for an enemy to attack the back of a dinosaur like this one? Why not?**

Now explain that although these three dinosaurs look fierce, they would not attack another animal to feed on it. These particular dinosaurs fed only on plants. However, other kinds of dinosaurs attacked and ate the kinds shown. Some of the plant feeders escaped their enemies by swimming; others were protected by horns or plates.

Through further discussion of the story and study of the pictures, lead children to these assumptions:

There were different kinds of dinosaurs.

Some were very big, and some were small.

Some had special parts that were useful for getting food or for protection from attack.

Extending the Concept

Through Key Concept Words. Add *horns* and *plates* to the Science Vocabulary Chart.

Through Art. Have children make pictures of some of the kinds of dinosaurs they have been learning about: duck-billed, horned, and plated. Some children may want to make models of dinosaurs.

Some dinosaurs were nearly as big as whales.
Others were as small as chickens.
Some could swim.
Some had mouths like ducks' bills.
Some had big horns on their heads.
Some had hard plates on their backs.

LESSON 3, page 131

SUBCONCEPT: Life in the past is reconstructed from fossil remains.

Aim of the Lesson

To lead children to the discovery of how dinosaurs lived.

Introducing the Lesson

REQUIRED: some dinosaur pictures made by the children.

Exhibit a few of the pictures made by the children. Let the child who made each picture identify his or her drawing and explain it to the group. Then encourage the children to discuss some of the things that they have learned about the dinosaurs in the pictures.

Developing the Concept

(by emphasis on the subconcept)

1. Have children study the pictures on page 131. Call on a child to describe the part of the picture on the left. Does it show a dinosaur that fed on plants? What is the dinosaur eating in the picture?

2. Call on a child to describe the scene on the right of page 131. **What is this dinosaur feeding on?** Encourage children to wonder at the vast amount of plant food that must have been required to satisfy these huge plant eaters. **Does it seem likely that nearly all of their nonresting time was spent in feeding?**

3. Choose someone to describe the third picture on the page. **What are those pale objects lying on the ground?** Most children will recognize that they are eggs.

Some dinosaurs fed on plants that grew
in the forests and swamps.
Some dinosaurs fed on meat.
The meat-eaters killed other dinosaurs
to use for food.
Dinosaurs laid eggs.

4. Direct attention to the story on the bottom of the page, and read the sentences (or have children read them) one at a time. Follow each sentence with appropriate comments and questions:

Sentence 1. Turn back to page 128 and find the picture of a dinosaur that fed on plants. This was one of the biggest kinds of dinosaurs. Look at page 130, and find three other kinds of dinosaurs that fed on plants. Tell us something about each of these animals. Again point to the dinosaur on page 131 that fed on plants.

Sentence 2. Turn back to pages 128 and 129, and find a picture of a dinosaur that fed on meat. **What do you see in the dinosaur's mouth?** (Help the children to choose the dinosaur (Tyrannosaurus) on page 129, shown with its teeth bared, as the one that fed on animals.) **Why do you think this kind of mouth was good for an animal that depended on meat for food?** (Guide attention to the long, sharp teeth that were used for biting meat. The teeth were about 8 inches long and as sharp as knives. You may wish to have children measure 8 inches with a ruler to show the length of a tooth.)

Sentence 3. Look on the lesson page for a picture of a dinosaur that fed on meat. **Where is it getting the meat? Did the dinosaurs that fed on meat actually depend on plants as a source of their food? Could they have lived if there had been no plants?** (Help children to see once again that only plants make their own food; the meat eaters ate the plant eaters and probably one another. If there had been no plants there would have been no animals to supply meat.)

Sentence 4. Look at the picture of the eggs at the bottom of the page. **What kind of eggs do you think they are? What kind of animals hatched from dinosaur eggs? Do you think that turtles or snakes or other kinds of animals ever hatched from dinosaur eggs? Why not?** (If necessary, refer back to Unit Eight, where like produces like was developed.)

Extending the Concept

Through Activity. To extend some thinking beyond the lesson you may wish to discuss the following:

There were once many dinosaurs on the earth, but all died millions of years ago. **Can you think of some reasons why this may have happened?** You probably will need some guiding questions:

What would happen if the land changed so that the plants that dinosaurs fed on no longer reproduced themselves?

Could the plant-feeding dinosaurs continue to live?

Could the meat-feeding dinosaurs continue to live?

What would happen if some other animals came along and fed on dinosaur eggs or the weather was too cold for the eggs to hatch? Could there be more dinosaurs if their eggs never hatched?

What would happen if some kind of sickness spread among the dinosaurs, so that all the baby dinosaurs died?

Let children discuss these and other things that might have happened. Then tell them that scientists have long been studying the problem of the disappearance of dinosaurs. The scientists still do not know exactly what happened. They still do not agree on the reasons for their disappearance.

UNIT ELEVEN: LONG, LONG AGO

Section 2: Evidence of Past Life Buried in the Earth

CONCEPT
Animals of the past were different from the animals of the present.

LESSON 4, page 132

SUBCONCEPT: Life in the past is reconstructed from fossil remains.

Aim of the Lesson

To present fossils as the source of evidence of the existence of dinosaurs.

Introducing the Lesson

Remind the children once more that there were no people on Earth at the time the dinosaurs lived. Yet we know quite a bit about dinosaurs. This leads to the question:

How, then, do we know that there were once dinosaurs living in places where we live today?

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: several chicken bones, a box containing dry sand (or soil) about 2 inches deep, and more sand in another container.

1. Invite children to study the picture at the top of page 132. Call on someone to try to explain what the men are doing and what they have found. Help children to recognize that the men are digging into the earth and have found some large bones.

Present the problem of how the bones may have become buried in the earth. Without commenting on any child's explanation, suggest using the chicken bones and the box of sand to demonstrate one way that the bones may have become buried.

Explain that the top of the sand or soil is the surface of the land and that a chicken lives on this land. When the chicken dies or is killed by some animal, its body lies on the ground. The soft or meaty parts of its body are eaten by other animals or they decay. The feathers are blown away by the wind, and the bones are left on the ground.

Have a child come forward and place the chicken bones on top of the sand in the box. Tell the class to imagine that *all* the chicken's bones are on top of the soil.

Explain that the Earth changes. Wind, water, volcanos, and earthquakes move the Earth's crust soil from one place to another. At this point, cover the chicken bones with a thick layer of sand. The chicken bones are now buried in the earth.

If no one ever saw a chicken, how could we find out that an animal which we call a chicken once lived on this land?

Children will be quick to explain that by digging they could find the bones. Point out that the bones in the picture were buried for millions of years; they are called ***fossil bones.***

2. Now direct attention to the picture at the bottom of the page. Ask what the men are doing with the fossil bones.

Children will see that the fossils are being cleaned. Then numerals are put on each piece. Numerals will help scientists to put the bones together.

Through further study of the pictures, help children to reach the following understandings:

An animal died and its bones became buried in the earth.
The bones stayed buried for a long, long time.
When men dug into the earth, they found the fossil bones.

So that the class will know what *kind* of fossil bones the men are digging from the earth, have someone read the caption on the page.

Extending the Concept

Through Activity. Let children discover how fossil prints were made by making some plant and animal prints of their own. Press sea shells, acorns, snail shells, leaves, bones, fern fronds, etc. into damp sand or soft clay. Human prints may be made by pressing hands into sand or clay.

Through Key Concept Words. Add *fossil* and *bones* to the Science Vocabulary Chart.

The men dig for bones of a dinosaur.

LESSON 5, page 133

SUBCONCEPT: Life in the past is reconstructed from fossil remains.

Aim of the Lesson

To show children how we know what the different kinds of dinosaurs looked like.

Introducing the Lesson

REQUIRED: The bones from the leg of a chicken or turkey. Ask children to put the parts together. Ask how they know which parts fit together. Ask this question: **If someone dug up these bones thousands of years from now, could they put the bones together?**

Write *fossil* on the board, and call on individuals to tell what they know about fossils. Review briefly the preceding lesson (page 132), and help children to recall that *fossil bones* of dinosaurs were excavated. Create interest in the lesson by posing this question:

What is done with the fossil bones of dinosaurs?

Developing the Concept

(by emphasis on the subconcept)

Have children look at the pictures on page 133. Call on individuals to describe what they see. The children will see that only two kinds of dinosaurs are shown. They will recognize that the "whole" of each kind is shown beside its bones. Introduce the word, ***skeleton***, and explain what it means.

How do we know about dinosaurs?

133

Now ask children whether they can figure out where the dinosaur skeletons came from. Refer to page 132 and to the chicken bones in the sand to help the class to understand that the skeletons were put together from fossil bones (or reproductions of the bones) that were dug from the earth.

You may wish at this point to say a few words about the scientists (paleontologists) who work with fossil bones.

When scientists discover fossils in the ground or learn of such a discovery, they dig the fossils out with great care.

The fossils are shipped to workrooms (laboratories), where the scientists study them.

The bones of an animal are fastened together to make a skeleton.

From the skeletons, scientists make models that show us what the living dinosaurs looked like.

Call on individuals to tell whether they have seen pictures of the kinds of dinosaur shown on the page (Lessons 1 and 3). Ask once more which is a meat eater and which is a plant eater.

Conclude the lesson by having someone read the question at the bottom of page 133. Through discussion of the question, lead children to these understandings, expressed in their own words:

We know about dinosaurs from their bones that were buried in the earth.

The bones remained in the earth for millions of years.

The fossil bones were excavated and assembled into skeletons.

Scientists work with dinosaur fossils and find out what the living dinosaurs looked like.

Extending the Concept

Through a Field Trip. If there is a natural history museum in your community, take the children there to see fossils and skeletons of prehistoric animals.

Through Key Concept Words. Add *skeleton* to the Science Vocabulary Chart.

Through Activity. Plan a fossil exhibit in the classroom. Some children may be able to bring in fossils that their brothers, sisters, or parents have collected. Fossils may also be borrowed from high school or college science departments or from museums. Inform the children that any imprint of something that once lived can be called a fossil.

With Rapid Learners. Teach children to say the names of the different kinds of dinosaurs shown in the pictures in the textbook: *Brontosaurus,* one of the largest of the dinosaurs (page 128); *Tyrannosaurus,* the largest carnivorous dinosaur (page 129); *Triceratops,* one of the horned dinosaurs (page 129 and 130); *Trachodon,* one of the duck-billed dinosaurs (page 130); *Stegosaurus,* a plated dinosaur (page 130); *Allosaurus,* a carnivorous dinosaur (page 131); and *Camptosaurus* (page 131).

Plastic or metal models of dinosaurs are useful in helping children become familiar with the names of the various species.

Through Art. Use clay or plaster of Paris to make a fossil imprint of each child's hand. When painted, this can make an attractive wall plaque or paperweight — an interesting gift to take home.

UNIT ELEVEN: LONG, LONG AGO

Section 3: Mammoths

CONCEPT
Animals of the past were different from the animals of the present.

LESSON 6, page 134

SUBCONCEPT: Life in the past is reconstructed from fossil remains.

Aim of the Lesson

To introduce further experience with fossil history; in this case, the mammoth, a prehistoric animal of the elephant family.

Introducing the Lesson

REQUIRED: Pictures of elephants (if necessary use page 110 of the pupil's textbook).

Have children look at the picture of the elephants and name their special features: skin covered with hair (of baby only), trunk, flapping ears, and tusks. Help children to recall (from Unit Nine) that elephants, like whales, are mammals.

Were there any mammals much like elephants on the Earth long, long ago?

Developing the Concept

(by emphasis on the subconcept)

1. Have the children look at the picture of the mammoth on page 134. Ask what this strange big animal looks like. Most children will promptly identify it as an elephant.

Ask the class to look at both animals on the page and find out if they are alike. With little prompting, the children will point out trunks, tusks, size, big legs, etc. They may think that both the animals are elephants.

Agree that they both *look* something like elephants.

2. Have someone read the title of the story. Then proceed with the story by reading each line aloud or by calling on children to do so. Stimulate discussion of the sentences by presenting comments and questions about each one:

Sentences 1 and 2. Look at the picture of the elephant. **Do elephants live where we live today (in our country)?** Elephants do not live *naturally* in our country today.

Sentence 3. **Do the animals in the picture have hair on their bodies? What class of animals generally have hair on their bodies: birds, reptiles, fish, mammals?**

Sentence 4. Look at the animals' trunks. **Is a trunk a special kind of mouth, or a special kind of nose?**

Sentence 5. **Does the *hairy* animal in the big picture have *tusks* that look like the tusks of the elephant? Do they differ?**

Sentence 6. **Did any of these hairy animals hunt other animals and use them for food?** Explain your answer.

Sentence 7. One meaning of the word mammoth is "very large." **Why do you think this kind of animal is called a hairy (or wooly) mammoth?**

Write ***mammoth*** on the board, and have the children pronounce the word several times. Then have them find *mammoth* in the last line of the story in their textbooks. There are no mammoths living today.

Now ask the children to compare the picture of the mammoth with the picture of the elephant. Try to guide children to observations like these:

Elephants and mammoths are both large mammals.

They look somewhat alike. Both have long trunks, big tusks, and thick legs.

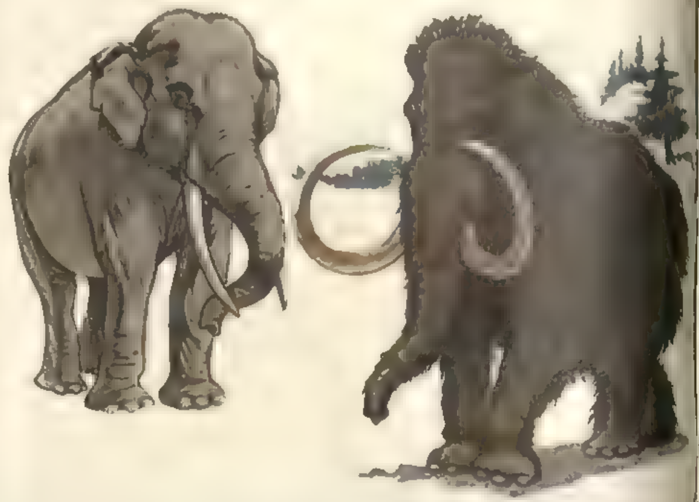
Mammoths are more hairy.

Mammoths have tusks that are longer and more curved.

Extending the Concept

Through Art. Give children large pieces of clay and invite them to model animals that lived long, long ago. Encourage them to form mammoths and various models of dinosaurs.

Through Key Concept Words. Add *mammoth, hairy, tusks,* and *trunk* to the Science Vocabulary Chart.



Something Like an Elephant

Long, long ago, a big animal lived.

It lived where we live today.

Its body was covered with hair.

It had a trunk like an elephant's.

Its two front teeth grew into long tusks.

It fed on trees and other plants.

It was a hairy mammoth.

LESSON 7, page 135

SUBCONCEPT: Life in the past is reconstructed from fossil remains and artifacts.

Aim of the Lesson

To present a view of prehistoric men living during the time of mammoths.

Introducing the Lesson

From a brief review of Lesson 1, page 128, have the children recall that there were no people on Earth when dinosaurs lived. There also were no mammoths. Develop the idea that mammoths appeared many, many years after the dinosaurs had died and disappeared. Lead children to wonder: **Were there men on the Earth when mammoths were alive?**

Developing the Concept

(by emphasis on the subconcept)

1. As soon as children look at the picture on page 135, they will announce that there *were* men during the time of mammoths. Tell them that this is a picture of what could have *really* happened. Men did hunt mammoths. Call on individuals to describe the men in the first picture. **What are they wearing? What are they doing?**

2. Then direct attention to the second picture on the page, and ask where the man is and what he is doing. Through discussion of the two pictures, help children to make these interpretations:

Man lived at the time of mammoths.

Long, long ago men hunted mammoths.
They used mammoths for food.
They drew pictures of mammoths
on the walls of their caves.
There are no mammoths today.
They died out many, many years ago.

In the first picture, men are hunting mammoths.

In the second picture, a man is in a cave. He is making a picture of a mammoth on the wall of the cave.

3. Now refer to the story beneath the pictures. Read the story aloud, or call on children to read a line at a time. Stimulate discussion by following each sentence with pertinent comments and questions:

Sentence 1. **Are the hunters carrying guns? What are they carrying?** (Explain that the men of this long-ago time had no guns. They had no metal of any kind. They used to dig big holes in the ground or used muddy water holes to trap mammoths. Then they would kill the trapped animals with big rocks and long spears tipped with stone. These were men of the ***Stone Age.***)

Sentence 2. **Why did Stone Age men hunt mammoths and kill them? What did mammoths depend on for food?** Stone age men also ate some kinds of plants. **What else did they eat?**

Sentence 3. **What is the man making on the wall of the cave?** Pictures like the one the man is making have lasted for thousands of years. They still may be seen today.

Sentences 4 and 5. We can also say that mammoths are ***extinct.*** When any kind of animal dies out, we say that it becomes extinct. Mammoths have been extinct for many, many years (for about 10,000 years), but nowhere near as long ago as another animal that you know became extinct. **What was that other animal?** (The dinosaur has been extinct for millions of years.)

Now present a problem for discussion: **If mammoths have been extinct for so long, how do we today know what they looked like?**

Encourage children to use the cave pictures as evidence that shows us what a mammoth looked like. Then ask if there is any other way in which we may have learned about mammoths. Guide the discussion toward bones and *fossils*, and lead children to the assumption that bones of mammoths, like those of dinosaurs, may have become buried in the earth. These bones have been dug up by modern man. (If children suggest that Stone Age men may have written about mammoths, explain that these early men had no writing except pictures.)

Conclude the lesson by rereading the story as children study the pictures. Through discussion, lead the class to these understandings:

Men were on the Earth when mammoths lived.

Men hunted mammoths and used them for food.

Men made pictures of mammoths. The pictures can still be seen.

Bones of mammoths have been found by modern man and put together.

Mammoths have been extinct for a long, long time.

Extending the Lesson

Through Key Concept Words. Add *Stone Age* and *extinct* to the Science Vocabulary Chart.

Through Art. Direct children's attention to the colors used by the Stone Age artists shown on page 135. Then encourage children to use similar colors in making large "cave pictures" of mammoths. Charcoal and colored chalk may be used for especially effective drawings.

LESSON 8, page 136

SUBCONCEPT: Life in the past is sometimes reconstructed from preserved remains.

Aim of the Lesson

To show how a complete mammoth, frozen in the earth since prehistoric times, has contributed to our knowledge about mammoths.

Introducing the Lesson

Write the word *extinct* on the board and review its meaning. Lead the class into a discussion of how we have learned about extinct animals. Stress fossils as yielding important and accurate evidence. Mention the chicken bones again to recall the idea that bones and other hard parts are usually all that we have to tell us about extinct animals. Then lead into the lesson with a question:

How could a whole mammoth — skin, hair, and soft parts as well as bones — last for thousands of years?

Developing the Concept

(by emphasis on the subconcept)

1. As children open their textbooks to page 136, direct attention at once to the story. Call on someone to read the title. Ask for volunteers to explain the meaning of ***deep freeze.*** Many children will be familiar with the deep freeze as a place to keep meat and other foods for a long time. However, you may need to develop the idea for some.

2. Proceed with the story a line at a time following the steps that have been used in preceding lessons. Have the children study the pictures as the lines are read. Comments and questions like these may be useful:

Sentence 1. Find the picture of the dog. **What does the dog see sticking out of the ice and *frozen* earth?** The dog is a modern live dog.

Sentence 2. **Could the dog dig the animal out? Why not?**

Sentence 3. **Why would workmen have to use picks and axes and shovels?**

Sentence 4. **What did the men find when they dug away the ice and frozen earth? Do you think that the mammoth was soft or hard while inside the frozen earth?** (Here help children to recall what a package of frozen food feels like when it is taken out of the deep freeze.)

Sentence 5. **How do you know that the mammoth must have been frozen in the earth for many, many years.** (Encourage children to use some of the ideas about mammoths that have already been developed.)

3. You may wish now to tell the class something more about the mammoth in the deep freeze:

The deep-freeze mammoth in our story was found not very long ago, far away on the other side of our Earth (Siberia in 1901). When the mammoth was dug out of the frozen earth, it was found to be perfectly preserved. It was as though it had just recently been placed in a modern deep freezer. Its blood, hair, flesh, and all its inner parts were in good condition. Its last meal (27 pounds of plant material) was still in its stomach. The meat, or flesh, of the mammoth had kept so well that great pieces of it were cut off and fed to the dogs, which are shown in the picture.

Other mammoths, less completely preserved, have been found in our state of Alaska. Scientists have learned a great deal about mammoths by studying those found frozen in the earth. Scientists today know exactly what a living mammoth was like, even though mammoths were extinct long before man had learned to write.

By the close of the lesson, children should be able to express in their own words the following ideas about the pictures and story:

Long, long ago, a mammoth was frozen in the earth. The ice and frozen earth made the whole mammoth keep for many, many years.

The frozen mammoth was found in modern times. It was dug from the frozen earth.

Scientists studied the whole mammoth and learned what it was like when it was alive.

Extending the Concept

Through Key Concept Words. Add *deep freeze* and *frozen* to the Science Vocabulary Chart.

Mammoth in a Deep Freeze

One day a dog found a strange animal.

It was frozen in the earth.

Men dug away the ice and frozen earth.

They found a whole mammoth.

It had been frozen for many, many years.

LESSON 9, page 137

SUBCONCEPT: Life in the past can be constructed from preserved remains.

Aim of the Lesson

To give children experience that helps them discover how animals may be preserved in ice.

Introducing the Lesson

REQUIRED: some ice cubes or an ice-cube tray filled with water.

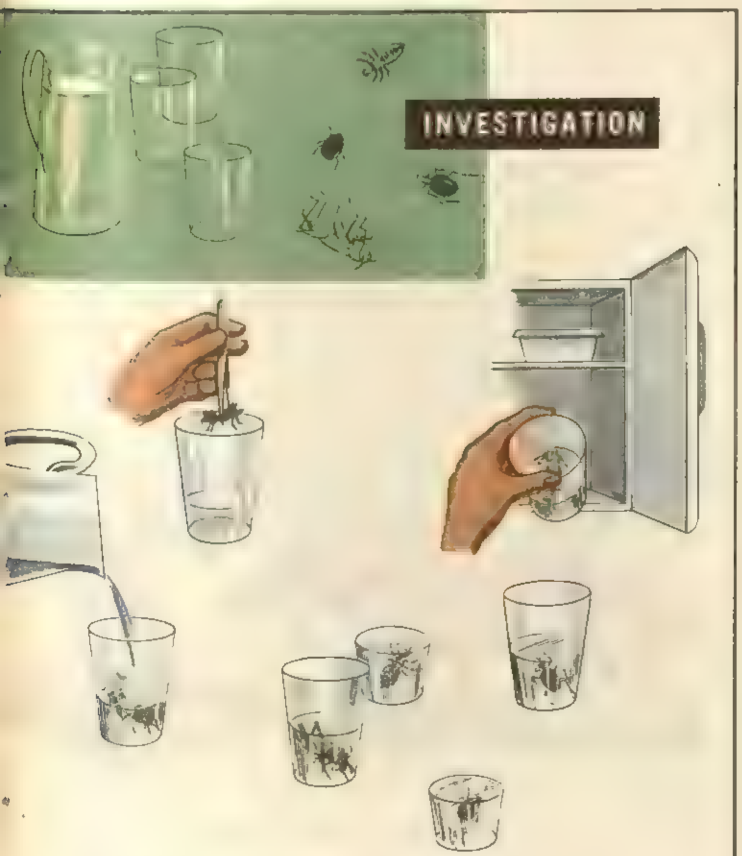
Present the ice cubes or the tray filled with water, and review *freezing* and *melting* (developed in Units Four and Five). Help children to recall what happens to water when it becomes very cold in the freezer compartment of a refrigerator or outdoors on a very cold day. As an incentive for the lesson ask: **If something is frozen in ice, will it stay there until the ice melts?**

Developing the Concept

(by emphasis on the subconcept)

REQUIRED: several small transparent plastic cups, a few dead insects of the kinds shown on the pupil's page, water, and the use of a refrigerator compartment. NOTE: if a freezer compartment is not available, the investigation may be described and discussed.

1. Call on someone to describe the materials that are needed for today's investigation. As the insects are mentioned, explain that they are ***dead.*** Their lives ended naturally, and they were found already dead; they were not killed in order to make this investigation.



How long will the insect stay the same?

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2. Then let children follow the pictures as they describe the steps in the investigation. Offer any comments that seem necessary to give the class a clear understanding of each step:

1. A dead insect is dropped into a cup that contains water.
2. The cup with the dead insect floating on top of the water is placed in the freezer compartment of a refrigerator.
3. The water freezes solid. The insect is frozen to the top of the ice. The frozen insect is covered with more water. Then the cup is put back into the freezer.
4. The water changes to ice. The dead insect is now completely surrounded by ice. It is frozen inside a piece of ice.

3. Direct special attention to the last picture, where complete insects are seen frozen in the ice. Present some questions for discussion:

What will these insects look like a week from today if the ice does not melt? a month from today? a year from today?

Will the insects change as long as they are frozen in the ice?

Call on children for their answers, and through discussion help them to reach these assumptions:

As long as the ice does not melt, the insect will remain the same.

It will decay or be eaten by live insects if the ice melts.

Finally, to emphasize the chief aim of the lesson, ask how this investigation helps to explain about the frozen mammoth of Lesson 8. With a little help, children will reason along the following lines:

Long, long ago a mammoth was stuck (mired) in a muddy place. Before it was able to get out, the water in the mud froze, and more water covered its body.

Its body became frozen hard, surrounded by ice and frozen earth.

The place stayed frozen for many years.

The whole mammoth lasted because it was frozen. The mammoth was ***preserved*** in the frozen earth in the same way that the insects in the investigation are preserved in the ice. As long as the mammoth remained frozen, it remained unchanged.

Extending the Concept

Through Following Up an Investigation. If freezer facilities are available in your school, assist children in carrying out the investigation shown on page 137. If no freezer is available, ask for volunteers to do so at home. (A fly or an ant will suffice as a specimen.) Some of the children, with help from parents, may be interested in freezing dead insects in ice, following the steps that were discussed in class.

Through Key Concept Words. Add *dead* and *preserved* to the Science Vocabulary Chart.

Through Activity. Invite children to bring in empty boxes from frozen foods that have been purchased in stores. Use them for an exhibit showing that we buy and use foods that are preserved by freezing.

UNIT ELEVEN: LONG, LONG AGO

Section 4: The Sabertooth

CONCEPT
Animals of the past were different from animals of the present.

LESSON 10, page 138

SUBCONCEPT: Life in the past can be constructed from fossil remains or preserved specimens.

Aim of the Lesson

To introduce the sabertooth as a prehistoric member of the cat family.

Introducing the Lesson

SUGGESTED: a picture of a modern cat.

Initiate a discussion by inviting children to share information about pet cats. Through the discussion, bring out the fact that cats are mammals and that they feed on meat and milk. Lead into the lesson with this question:

Were there any cats long, long ago?

Developing the Concept

(by emphasis on the subconcept)

1. Have children look at page 138 as you read, or help a child to read the title of the story. Ask them to study the picture of the animal on the page to find out ways in which that animal resembles a cat. Through appropriate questioning, guide children to observations like these:

It looks something like a cat, but it is much bigger, stronger, and more fierce.

Two of its teeth are very long.

Now ask children to think of some animal they have seen that looks like the one on page 138 — perhaps in a zoo or circus, or pictured in a book. As pupils mention *lions* and *tigers*, or other kinds of cats, write the words on the board. Above them, write *cat family*. Explain that lions, tigers, and the pet cats in our homes all belong to the same big family of animals, the cat family.

2. Then direct attention to the story, which tells about another member of the cat family. Before reading the first sentence, write ***sabertooth*** on the board, and explain the word, *saber*, as a long knifelike tool (sword) with a curved blade. Explain that a saber was used by soldiers for slashing and stabbing. Children will understand that the animal is named for its two saberlike teeth.

Proceed by reading of the story. Suggestions for questions and comments are included below:

Sentence 1. **Why do you think we cannot see a live sabertooth in a zoo or a circus?**

Sentence 2. **Why does the sabertooth remind us of cats, tigers, and lions?**

Sentence 3. **What are its two long, sharp teeth like? How do you think the animal used its two saberteeth?** (Again refer to the saber and recall its use. The saberlike teeth were 8 or 9 inches long. Let children measure the length on a ruler.)

Sentence 4. When the sabertooth slashed and stabbed at other animals, its teeth were sharp enough and strong enough to cut through the tough skin, flesh, and perhaps even to break bones. (Fossil discoveries indicate that the sabertooth cats of the California area preyed on camels, huge bears, young mammoths, and especially animals that were fat and slow.)

Sentence 5. **Why did the sabertooth kill other animals?**

Through discussion, try to lead children to the understanding that meat-eating animals must feed upon other animals. Ordinarily, such animals do not kill until they are hungry.

Extending the Concept

Through Activity. Invite children to bring in pictures of animals that are members of the cat family — wild and domestic. Use these pictures, along with some that you have collected, to develop a "cat family" chart.

Through Investigation. Encourage children to observe the hair (fur), whiskers, paws, and claws of a pet cat.

Through Key Concept Words. Add *lion, tiger, cat family,* and *sabertooth* to the Science Vocabulary Chart.

Something Like a Cat

The sabertooth lived long, long ago.
It looked something like a cat.
It had two long, sharp teeth.
It used its teeth to kill other animals.
It used other animals for food.

LESSON 11, page 139

SUBCONCEPT: Life in the past is reconstructed from fossil remains and preserved specimens.

Aim of the Lesson

To lead children to the discovery of how animals of long ago were sometimes caught accidentally in pools of tar and thus preserved in the tar.

Introducing the Lesson

SUGGESTED: a jar of rubber cement and several sticks of wood about the size of a pencil.

Write ***tar*** on the board, and try to find out what the children know about tar. Try to get some children to recall seeing liquid tar being applied to streets, roads, or roofs of buildings.

Then show the class the jar of rubber cement, and explain that it is not tar but is to be used to represent the liquid tar. Have children come forward and put the sticks into the rubber cement. Let them see how it clings to each stick and makes the removal somewhat difficult.

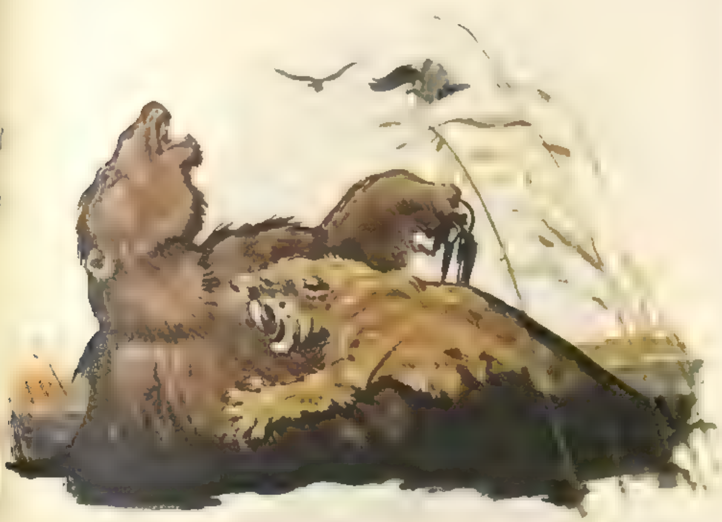
Lead into the lesson by asking:

What would happen to an animal that fell into a deep pool of liquid tar (or of rubber cement)?

Developing the Concept

(by emphasis on the subconcept)

Direct attention to the picture at the top of page 139. As children study the picture, tell them about tar pools.



A big bear came to drink.

Its feet stuck in the tar.

A hungry sabertooth jumped on the bear.

It fell off the bear and into the tar.

Both animals were caught.

They were caught for thousands of years.

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Long, long ago, scattered across a part of the land (now California), were strange, dark pools. The pools were deep. They were filled with soft, gummy tar, which came from oil that oozed up from within the warm earth.

When it rained, water covered the thick, soft layers of tar. A water-covered tar pool probably looked like any pool of water with black mud on the bottom. But the bottom was not mud; it was sticky tar. Sabertooth cats, mammoths, camels, bears, and other animals sometimes came to drink from these pools. If an animal stepped into or fell into the tar pool, there was no way to get free. The pools were traps, and many animals that went for a drink were caught in the tar.

Read the story that tells what happened to the animals in the picture.

Proceed with the sentences, reading them aloud or calling on children to read them. Give emphasis to the story by presenting some comments or questions after each sentence is read.

Sentence 1. **Why did the bear come to the pool?**

Sentence 2. **What happened to the bear when it waded into the water to drink? What is the bear trying to do? Why can't it get its feet free?**

Sentence 3. **Why did the sabertooth come to the pool? Why did it jump on the bear? Why did it want to kill the bear?**

Sentence 4. **Did the sabertooth stay on the bear's back?** Perhaps the big bear shook off the sabertooth. **Into what did the sabertooth fall?**

Sentence 5. **Why were both animals caught? What do you think happened as they struggled to get free?** (They sank deeper and deeper into the tar.)

Sentence 6. **Were they ever able to get out of the tar? How do we know that animals were not able to get out of the tar pools?**

The children will reason that the animals were held (preserved) in the tar because we have found fossils. Explain that the soft parts of the animals disappeared in time.

Check children's comprehension by presenting a true story for discussion:

A certain kind of large bird (vulture) feeds on the flesh of dead animals. These birds waited near a tar pool for an animal to be caught. Then they would circle around the pool until the animal died or was helpless. Sometimes they flopped down on the water to check on the animal and their wings or feet touched the tar. **What do you think happened to the birds then? How do we know what happened?**

Children will reason, correctly, that the birds, like the large animals, were caught in the tar. Their bones were preserved in the tar along with the bones of other animals that were caught.

Extending the Concept

Through Activity. Have children put both index fingers into a blob of molding clay. Even though it is not sticky like liquid tar, the children will recognize the difficulty of getting their fingers out of the clay without assistance.

Through Key Concept Words. Add *tar* to the Science Vocabulary Chart.

LESSON 12, pages 140 and 141

SUBCONCEPT: Life in past is reconstructed from fossil remains and preserved specimens.

Aim of the Lesson

To explore further the idea of fossil evidence: fossils dug out of the tar pits in Los Angeles are used as examples.

Introducing the Lesson

SUGGESTED: a piece of hardened tar or asphalt (frequently available at a street repair job, a roof-tarring job, or a big building-construction job).

Through discussion, review the characteristics of the pools of tar in which the sabertooth and other animals were caught. Then, by presenting the tar or asphalt, or by describing hardened tar, help children to understand that in time the soft, gummy tar in the long-ago pools became solid. Lead into the lesson with a question:

What do we find when we dig into the tar in which the sabertooth was caught long, long ago?

Developing the Concept

(by emphasis on the subconcept)

1. Invite children to look at the picture on page 140. Call on someone to describe what the men are doing in the picture. Through pertinent questions or leading statements, try to bring out the fact that the men are digging up the hardened tar. They are digging in ***tar pits,*** which were formed when the tar in the long-ago tar pools hardened. (You may wish to tell the children that the men are digging in a big city — Los Angeles.)

Ask what the men are finding in the hardened tar. Suggest to the children that bones are embedded in the tar. Ask if anyone ever saw an animal with black bones. Help the pupils to understand that the bones became black because the liquid tar soaked into them, and then the tar hardened.

Call attention to the fact that there are no whole animals in the pit. Explain that the soft parts of the animals were squeezed away by the tar. By questioning, guide children to the observation that the tar soaked into the hard parts, bones and teeth, and surrounded them without crushing them.

2. Now call attention to the picture of the sabertooth skull. Refer to it as a fossil, and ask children to think about the things that a scientist could learn from studying such a fossil. Try to get them to realize that the fossil ***skull*** shows the size and shape of the animal's head, the way its jaws opened, and the kind of teeth it had. Explain that scientists know from the animal's long, pointed teeth that it fed on meat. (Animals that feed on plants have different kinds of teeth — teeth for munching and grinding. They do not need sharp, knifelike teeth.)

Have someone read the question at the bottom of the page. As children volunteer their answers, guide them to these understandings:

Fossils of animals that were caught in the pools of tar are found in the tar pits (or "in the hardened tar").

The fossils are taken out of the hardened tar and are then studied by scientists.

3. Direct attention to page 141 and ask what kind of place is shown in the picture. If there are museums in your locality, children may be able to identify the setting as a museum. If not, introduce the word ***museum*** and explain that a museum is a place where people can go to learn about things by looking at them. In an art museum we look at art work. In a natural history museum, we can learn about things of the past from pictures and models.

Ask pupils to tell what the children in the picture are looking at. Encourage them to describe the skeleton of the sabertooth, and then consider the complete sabertooth that stands beside it. Where did the whole animal come from? Is it a stuffed animal that may have died in a zoo? Through discussion, develop the following understandings:

The sabertooth is not alive; and it is not the body of one from a zoo, because the sabertooth has been extinct for many, many years.

The skeleton was put together from fossil bones that were dug from a tar pit.

From studying many fossil bones and the places where they were found, scientists have learned a great deal about how the sabertooth looked when it was alive. Then they made a model of one.

If time permits, you may wish to explain how modern man can make a model of a sabertooth:

Scientists study the fossil bones to find out the size and shape of the animal. From its skeleton and its teeth, the scientists know that the animal belonged to the cat family. They build a body, with clay or plaster, over the skeleton, to make an animal that looks like a huge cat. They do not know exactly what the sabertooth looked like when it was

What do they find in the tar?

alive, and so they have to decide among themselves about its color, its eyes, and the kind of fur on its body. They think the sabertooth must have looked something like the big cat animals we have today — tigers and panthers. They make a model that looks as much like the sabertooth when it was alive as they possibly can.

However, we probably never will know whether or not the pictures and models of the sabertooth look in every way like the living animal. The sabertooth became extinct in our country long before there were any people here. We know about the big, catlike animal only from fossils.

(NOTE: Fossils found in Europe indicate that our ancestors, the Neanderthal people, probably fought the predatory sabertooth.)

Conclude the lesson by asking children to respond to the question at the bottom of page 141. Then, through discussion, help children to summarize the lesson and the unit by expressing in their own words ideas like the following:

> We know about extinct animals (sabertooth cats, dinosaurs, and mammoths) from fossils that have been found buried in the Earth's crust.
>
> The fossils are dug up and are then studied by scientists, who tell us (and show us), as nearly as possible, what the animals were like when they were alive.

Extending the Concept

Through Key Concept Words. Add *tar pits*, *skull*, and *museum* to the Science Vocabulary Chart.

Through Language. Write the Vocabulary words from Unit Eleven on the board, and call on children for oral sentences explaining the words as you pronounce them.

How do we know about the sabertooth?

Through Art. Suggest that children make pictures of some of the long-ago animals they have learned about. Use some of the best pictures on science reading charts composed to suit the children's reading ability. Use additional pictures for a class display on "Animals of Long, Long Ago."

UNIT ELEVEN: LONG, LONG AGO

Section 5: Summary and Evaluation

CONCEPT SUMMARY
Animals of the past were different from animals of the present. Life in the past is reconstructed from fossil remains and preserved specimens.

LESSON 13, page 142

Aim of the Lesson

To give children an opportunity to summarize and evaluate their understanding of animals of the past.

A New View of the Concept

Call on children to name three kinds of animals that they have learned about that are no longer living on the Earth. As children name them, write *dinosaur*, *mammoth*, and *sabertooth* on the board.

Call on someone to read the title on page 142. Then ask children to put their fingers on the pictures of each of the three animals as you say its name: mammoth, sabertooth, dinosaur.

Proceed with the lesson by reading each of the questions, or calling on individuals to do so, as the children follow the words in their textbooks. If you wish to use more than the eight questions that are printed on the page, follow each one with a few more as suggested below:

1. **What were some of the different dinosaurs like? What did they feed on?**
2. **What animals of today belong to the cat family? What did the sabertooth feed on? How did it get its food?**
3. **How can you tell that the mammoth belonged to the same animal family as elephants? What did mammoths use for food? How do we know?** (Plant materials were found in the stomach of the frozen mammoth.)
4. **What reptiles live on the Earth today?** (Snakes, turtles, lizards, crocodiles, and alligators.) **Are there any reptiles today as large as the largest dinosaurs?**
5. **How do we know that dinosaurs laid eggs? What are some animals that lay eggs today?** (All birds, all insects, frogs and toads, most reptiles, and most fish.)
6. **What *one* thing about mammoths and sabertooth cats shows you that they were mammals?** (Their bodies were covered with hair or fur.) **What are some mammals that live today?**
7. **What does it mean to be extinct? Do you think that there may have been other animals long ago that are now extinct?** (Yes, many kinds of animals and also many kinds of plants once flourished on the Earth and then died out.)
8. **Where do scientists look for fossils?** (They look in the Earth, where fossils are buried.) **What do scientists do with the fossil bones they dig up? What whole animal — hair, skin, flesh, and all the soft parts — was dug from the Earth? Why did the whole mammoth last all these years?**

Through discussion of things that lived and grew on the Earth long, long ago, and that live and grow today, guide children to these generalizations:

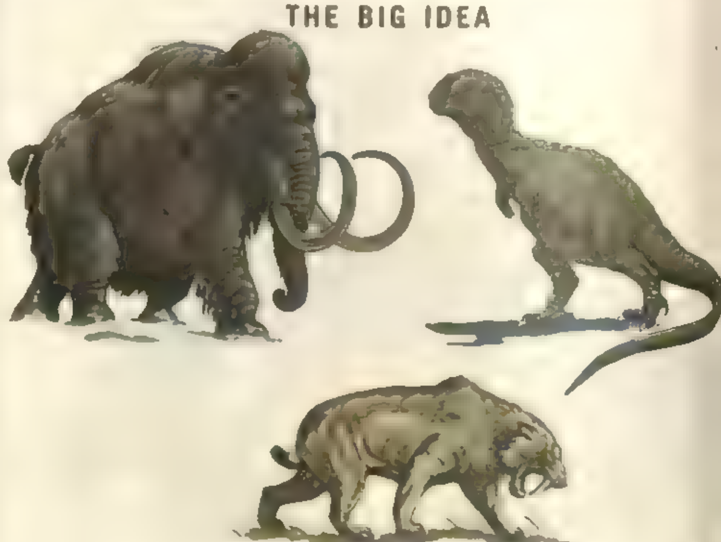
Long, long ago, many things that lived and grew on the Earth looked different from the way living things look today.

There were different kinds of plants and different kinds of animals.

Both plants and animals have changed and are still changing.

Explain that in time, some of the plants and animals that live today may become extinct (the trumpeter swan and the bald eagle may possibly disappear within our lifetime).

THE BIG IDEA



Which animal was something like a lizard?

Which one was something like a cat?

Which one was something like an elephant?

Which one was a reptile?

Which one laid eggs?

Which two were mammals?

STORIES FOR A NEW VIEW: CHANGES WE SEE

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Children live in a world of change. Some changes occur daily, some are experienced seasonally, some extend over a lifetime. Some changes are so gradual that the change is apparent only from evidence left behind for millions of years. The final section of this book is designed to increase a child's awareness of the changes he can see in his daily life, or of evidence he can see of changes that have occurred over long periods of time.

A child rises in the morning, is active during the day, goes to bed in the evening, and sleeps through the night. This is a daily change in a child's experience.

Most children, depending upon where they live of course, become aware of the changes in the seasons, from spring to summer to autumn to winter. In the spring new life appears in the bright green leaves to perform the food-making process for all living things. Summer is the year's daytime of fervent activity in preparation for the harvest. Autumn is the twilight time—the time of harvest and changing colors and migrating birds. Winter is the year's nighttime. These are yearly changes in a child's experience and provide an indirect way we have of knowing that the Earth has completed another orbit around the Sun.

Birth, growth, maturity, old age, and death represent a life cycle of change. At this time, however, children will find it difficult to comprehend this cycle except in relation to plants and animals with a shorter life span than their own.

Many changes occur in cycles, that is, in a pattern of repetition. Weather includes an example called the *water cycle,* evaporation to condensation to precipitation to evaporation to condensation to precipitation, and so on and on. Around and around it goes. The life process of reproduction perpetuates life in the following example: a chicken lays an egg which hatches into another chicken which lays another egg, and so on and on and on and on.

A young child perceives change as operating in one direction without being able to grasp the idea that certain fundamental features of things remain constant over change, or that if they change, the change is reversible. (This idea may be difficult to convey.)

The changing world of energy is a good example, for while energy may be changed from one form to another or transferred from one place to another, no energy is lost or gained. The total amount of energy remains constant. Mechanical energy can be changed into electrical energy, which in turn can be changed into heat energy, light energy, or mechanical energy. The mechanical energy of moving water can be transferred to become the mechanical energy of a turning wheel; it is still mechanical energy.

All matter is made of a few things which are being reshuffled constantly to form the variety of "things" children experience in their daily lives. Matter too can be shifted from one place to another with no loss or gain in the total amount of matter. For instance, water being evaporated from the ocean is carried inland by the wind as water vapor, and dumped onto the land as rain, sleet, or snow; but a constant feature of this cycle is that the water *always flows downhill* to the rivers and back out to sea. In its travels, the water is changing the face of the Earth.

Progressive change indicates an evolutionary progression from the simple to the complex. Living things have changed; but, while life is represented by a diversity of sizes, shapes, and characteristics, certain life processes have remained constant. The development of all living things is similar and consists of cell proliferation, growth, and differentiation.

This introduction has been merely to emphasize that the basic idea to convey with this end-of-book section is *change.* Be content if children come to accept change as a normal event in their life. Change is the one thing of which we can be sure.

STORIES FOR A NEW VIEW

CONCEPTUAL SCHEME
When energy changes from one form to another, the amount of energy remains unchanged.

STORY 1, pages 144 and 145

CONCEPTS

Energy is needed to produce motion or to alter motion.

Energy is the capacity to do work.

The more energy is used, the more work can be done.

Energy is used to do work against the pull of gravity.

Aim of the Lesson

To apply the concepts related to energy to familiar situations and thus to increase understanding.

Introducing the Story

REQUIRED: at least one large ball (several of different sizes and weights would be even better).

If the weather permits, the class will enjoy having at least the first part of this lesson outdoors.

One way to introduce the story is to present the ball, place it on the ground in front of the class and ask whether or not the ball is likely to rise into the air by itself. Then ask:

What can we do to make the ball go up?

Children will be eager to take turns throwing the ball into the air. As they do so, they will notice that when the ball is thrown especially hard (with much energy being used), it rises higher than when it is thrown gently (with less energy being used.) Compare the results when balls of different sizes and weights are used.

At this point, raise the problem that leads into the story:

If a person threw the ball very hard, using all the energy he can, would the ball just keep on going up and never come down?

The Story

REQUIRED: at least one ball; pieces of rock and wood; leaves or flowers; sand; water; or other materials and objects that can be made to fall without doing damage.

Invite children to look at the problem situation of the child on page 144. This is a very young child, probably only in kindergarten. He is trying very hard to do something.

Have some child read aloud to discover exactly what the young child on page 144 is trying to do. (He is trying to throw the ball so high that it will never come down.) Ask children whether or not they think it will be possible for the boy to do this. However, do not yet have them explain reasons for their answers.

Ask the children to find out exactly what happens to the ball: it goes up, higher than the boy's head; it stops going up; it comes back down.

After page 144 has been read, present some questions:

Do you think that the little boy was ever able to throw his ball so high that it never came down?

Do you think that any person can throw a ball high enough to make it touch a cloud that is high in the sky?

What *can* go very, very high into the air—as high or even higher than a cloud?

Through discussion, help children to express ideas like the following:

A young child does not have enough energy to make a ball go very high into the air.

Even a big, strong man would not have enough energy to throw a ball as high as a high cloud.

Airplanes and rockets, though, have enough energy to go very, very high. (Also, many kinds of birds and insects fly higher than any person can throw.)

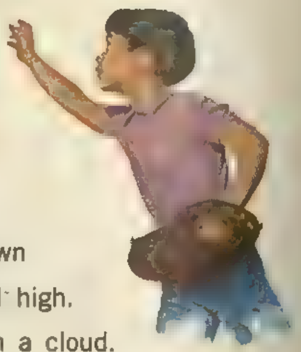
By now, the class should be ready to generalize: It takes energy to make anything go up.

If time permits, and if the class is sufficiently mature, they may be interested in a brief discussion of sources of energy.

Where does the little boy's energy come from? a man's energy? a bird's energy? (Food)

Where does a plane's energy come from? a rocket's energy? (Fuel)

Then refer the class to the top of page 145 to find out what the little boy does next. Children will see that he is watching sand run through his fingers. He looks very serious; he seems to be thinking about what he sees.



Up and Down

I will throw my ball high.
I will make it touch a cloud.
I will throw it so high
it will never come down.
My ball goes up,
but it always comes down.
Many things come down.

144

Is there anything in this picture that is like the one on page 144? In what way are the two scenes alike?

Once the children have discovered that in both pictures the child is watching something come down, or fall, they will be ready for a discussion of gravity.

Choose individuals to read the first two sentences on page 145. Call on volunteers to describe other things that fall, roll down a hill, or drop through the air. You may wish to prompt children by posing a few questions:

What happens to us if we stumble on the stairs?

What can happen to a baby bird if it gets too near the edge of its nest?

What happens to snowflakes in winter?

What will happen to this (rock, eraser, piece of chalk, cup of water, etc.) if I let go of it?

Close this phase of the discussion with some summarizing comment about the many, many things that fall down. *Things fall because* · · ·.

By now, most of the children will be fairly bursting to shout, **"Gravity!"** Many will be able to explain gravity as a force that pulls things toward the center of the Earth.

Now have someone read the last paragraph aloud. Conclude the review lesson with a discussion of a few pertinent problems like the following:

When the ball is going *up* (page 144), **which force is stronger, the boy's push or the pull of gravity? How do you know?**

When the ball is coming *down*, which force is stronger? How do you know?

Why can a rocket go higher than a plane?
(Gravity pulls on a rocket as well as on a plane; however, a rocket uses more energy.)

Sand falls through my fingers.
Leaves fall from the trees.
Rocks roll down the hill.
Water runs down the hill.
Raindrops fall to the Earth.
Gravity pulls things to the Earth.
My energy sends the ball up,
and gravity pulls it down.

145

Extending Concepts of Energy

Through a Playground Field Trip. Accompany the children to the school play yard. Help them to become aware of the functioning of gravity and energy in their use of play equipment. (1) A child uses energy to climb to the top of a slide; he slides down the chute because gravity pulls him down. (2) Energy is used to push or pump a swing; the energy from the pushing or pumping makes the swing move up in one direction, and gravity's pull makes it move down in the other direction. (3) On a see-saw, one child can push himself upward as gravity pulls the child on the opposite end downward; also, without any pushing, the heavier end will be lower because of gravity's pull. (4) It takes energy to climb up on a jungle gym, because gravity is always pulling downward; anyone who hangs upside down will find that coat, sweater, hair, and so forth, will hang downward and things may fall out of pockets, all because of the pull of gravity toward the center of the Earth. Exploring the pull of gravity in relation to playground apparatus affords a natural opportunity for reviewing safety rules.

STORIES FOR A NEW VIEW

CONCEPTUAL SCHEME
Living things are products of their heredity and their environment.

STORY 2, pages 146 and 147

CONCEPTS

Animals reproduce their own kind.

Some animals lay eggs which produce new offspring of their own kind.

Aim of the Story

To catch children's interest by means of a kind of "riddle"; to present a typical animal life cycle to serve as a basis for concept review.

Introducing the Story

REQUIRED: a hen's egg. Other kinds of eggs (from various birds, fish, amphibians, reptiles, or insects) would also be useful.

Show the hen's egg to the class. As children identify it as an *egg* that came from a *chicken*, write the two words on the board. Agreeing that the egg came from a chicken, ask where the chicken came from. When someone responds, "From an egg," ask where that egg came from.

Children will see that this could go on and on. At a convenient pause, tell the class that there is a kind of riddle about the chicken and the egg. Today's story is about this old riddle.

The Story

Refer the class to page 146, and read the title at the top of the page. Then choose volunteers to read each of the sentences. As *hens* and *roosters* are mentioned, help children to find the hen and the rooster in the picture at the bottom of the page. **Which one laid the egg (or eggs) shown in the picture?**

Continue now on page 147. Call on someone to describe one of the small pictures that surround the text. Choose someone else to describe another of the pictures. Continue until each has been described. Then ask, "Which is the *first* picture?"

Now ask someone to re-read the sentence that asks the riddle. As the last line is read again, let the children ponder the problem: The chicken comes from an egg that came from a chicken that came from an egg · · · etc., etc. Which *did* come first?

There should now be some discussion and disagreement among the children. **According to the pictures, where does the story begin?**

With the hens and roosters?
With the eggs?
With the baby chicks?
With the half-grown chickens?
And where does the story end?

Unless some child has not already done so, you will probably want to refer the class to the story on the page. Perhaps the story will tell which came first.

Read aloud the first five lines. *Does the story end here?* Choose someone to read the next four lines. Then go back to the beginning and read all nine lines over again.

Children will see that they could keep on reading these nine lines over and over again.

Read, or have a child read, the last two lines.

Now refer attention back to the pictures on the page. *Is any one of them really the first?* Children will see that they could follow the pictures around the page over and over again; there is really no first and no last, no beginning and no end. It just goes on and on.

If you have been able to secure any other kinds of eggs, this might be a good time to present them to the children. Identify each kind and, through pertinent questioning, involve as many children as possible in discussion to bring out facts like those given in the paragraphs below. (If you do not have actual eggs, you may wish to follow similar steps using pictures or descriptions of eggs.)

A *moth* lays its eggs on a green leaf. Caterpillars hatch from the eggs. The caterpillars grow. They spin cocoons. They rest and change. They emerge from their cocoons as

A Riddle

Hens lay eggs.

Chicks hatch out.

It takes twenty-one days for chicks

to hatch from eggs.

The chicks grow up.

Some grow up to become hens.

Some grow up to become roosters.

moths. The female moths then lay more eggs on leaves, and the story goes on.

A *turtle* lays its leathery-shelled eggs in a hollow in the stream. Tadpoles hatch from the eggs. The tadpoles live like fish. Then they change. They become toads and live on land. In the spring, the female toads lay their strings of jellylike eggs in the water, and the story goes on.

A *turtle* lays its leathery-shelled eggs in a hollow in the sand. Baby turtles hatch out. They find their way to food. They grow up. The grown-up female turtles lay more eggs in sand and more baby turtles hatch out, and the story goes on and on.

Through a discussion of various animal species that reproduce by means of eggs, help children to realize that the riddle of the chicken and the egg could just as well be about any other kind of egg-laying animal.

Some children may enjoy making up their own riddles, with a drawing to illustrate at least one stage in a life cycle. Some titles might be suggested:

The Grasshopper and the Egg

The Goldfish and the Egg

The Robin and the Egg

The Turkey and the Egg

The Butterfly and the Egg

Evaluate children's comprehension of like reproducing like by presenting a few direct questions for discussion as children look again at the pictures on page 147.

Could a duckling hatch from one of these eggs? Why do you think not?

If a duckling *did* hatch from an egg that was in a hen's nest, what would you know about that one egg? How would you know?

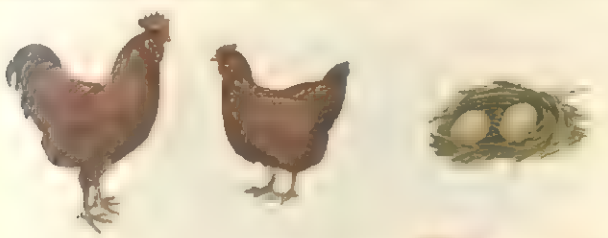
How do you know that the eggs in this picture are hen's eggs?

Extending the Concept

Through a Classroom Chart. Ask each child to bring in at least one picture of a kind of animal that lays eggs. The picture might be an original drawing, or it might be cut from a magazine or newspaper. Use at least one picture from each child on a large chart or on several charts. Head the charts, "Animals that lay eggs."

If there is good response to the assignment, you may wish to use some degree of classification in pasting the pictures onto the charts: *fish*, *amphibians*, *reptiles*, *birds* (probably the largest group of pictures you will receive, though by no means the largest group of egg-laying animals), *insects*, *mollusks*, *worms*, and so forth.

Nearly all animals, except the mammals, are egg layers. Exceptions are a few species such as garter snakes and rattlesnakes. There are even some rare species of egg-laying mammals, the duckbill platypus, and the echidna, or spiny anteater, natives of Australia.



The hens lay more eggs.
More chicks hatch out.
They grow into hens and roosters.
Which came first,
the chicken or the egg?
Would you say the chicken came first?
Would you say the egg came first?
Would you say there is no first?
It just goes on and on and on and on.

STORIES FOR A NEW VIEW

CONCEPTUAL SCHEME
When matter undergoes a chemical change, the total amount of matter remains unchanged

STORY 3, pages 148 and 149

CONCEPTS

Matter exists in various forms and states.

Energy from the Sun causes changes in the state of matter.

Evaporation and condensation are changes in state caused by energy exchange.

Aim of the Lesson

To help children to review the role of matter and energy in the formation of clouds and rain.

Introducing the Story

REQUIRED: water and a large green leaf.

Sprinkle several drops of water onto the leaf. Try to hold the leaf in such a way that drops are retained on its surface. (See first textbook illustration in today's lesson.) Show the drops to the class and ask whether anyone has ever seen a growing leaf holding drops. Was it very early in the morning? Or perhaps right after a shower of rain?

Call on volunteers to describe the appearance of the drops when the Sun shone on them.

What happened to the drops of water? Did they stay on the leaf? Did they soak into the leaf? Or did something else happen to them?

Before beginning the story, you may find it interesting to let volunteers describe fully what they think can happen to drops of water on a leaf.

The Story

Refer children to the story and pictures on pages 148 and 149 to check their assumptions about the drops of water. You may wish to follow a procedure somewhat like the following:

1. Look at the picture at the top of the first page. **Where did the drops of water come from? How did they get onto the leaf?**

Children will probably suggest that the drops fell as rain, or that they came from a lawn sprinkler. Someone, however, may refer to *dew*. If so, a simple explanation of dew, like the following, may be appropriate at this time:

Most of the time, there is some water vapor in the air around us. The water vapor is mixed in with the other colorless, odorless, tasteless, invisible gases that make up air. Sometimes there is a great deal of water vapor in the air. The water vapor stays in the air until it gets chilled. Then it changes to drops of water. When the drops form on or near the ground, we call the water "dew." Often the air gets chilled at night. Early in the morning we see dewdrops on the grass.

Perhaps the drops in the picture are dewdrops. **What happens to the drops?**

2. To find out, read the two lines just below the top picture. Did anyone in the class suggest that the drops of water would evaporate, or change to water vapor? (Refer to discussion at end of *Introducing the Story*.)

3. Read the next two lines to find out where the water vapor goes. Ask: **Can you see the water vapor going up? Why not?**

If the dew explanation has been given, it may be well to add here that some of the water vapor stays in the air around us, and some of it goes very high in the air.

4. The last two lines on the page tell us what happens to water vapor that goes high in the air.

5. What do we see in the picture at the bottom of the page? If water vapor is invisible, how does it happen that clouds are not invisible? (Review the formation of clouds from tiny *droplets* of water, pages 40–42.)

Next, present a few questions like these for thoughtful discussion:

Does a fluffy white cloud like the one in our picture ever change? Who has seen clouds change?

Do the tiny droplets of water in a cloud just float around in the air forever? If not, what do they do and why?

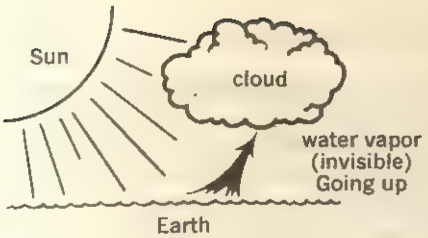
Encourage children to tell the next stages of what might be called "the travels of some drops of water."

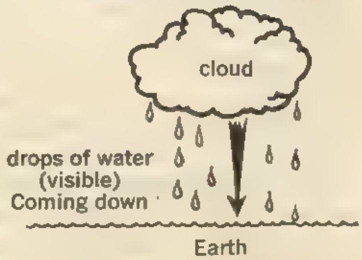
To verify their versions, children may next be referred to the picture and first two lines at the top of page 149.

Drops of water shine in the sunlight.
The water changes to water vapor.
The water vapor goes into the air.

Up, up goes the water vapor.
It becomes part of a cloud.
Wind pushes the cloud across the sky.

148





A diagram on the board, such as the one above, might be useful in showing the up and down travels of water.

Now ask children if they think this is the end of the travels of the drops of water. **Does the water stay down on the Earth this time? If not, why not?**

Choose someone to explain the last picture. Then read or have children read the final four lines.

Conclude the lesson by posing a few specific review questions:

What can change water from liquid to gas?

What do we call water when it is a gas?

What makes water vapor change back to liquid? ("Getting chilled" or "getting cold" really means "losing heat." There is no form of energy known as "cold." Hence, "cold" cannot cause changes in matter. The changes are caused by *loss of heat.*)

The cloud gets cold. It rains.

The rain falls to the Earth.

The Sun comes out.

The Sun shines on the water.

New clouds form. It rains again.

It just goes on and on and on and on.

When you look up at a cloud in a sky, how many things do you remember about clouds?

Most children will have at least one statement to make about clouds. As information is volunteered, use questions as needed to bring out the following points:

Clouds are formed from water vapor in the air.

The water vapor changes to tiny, tiny droplets of water in a cloud.

When a cloud loses heat (or gets chilled) the droplets change to drops.

Gravity pulls the drops down from the cloud.

Rain drops fall from clouds.

Water keeps on evaporating; clouds keep on forming; rain keeps on falling. It happens over and over and over again. It never stops happening.

Extending the Concepts

Through Language. During a language period, ask children to make up a story about what would happen if water kept on evaporating and forming clouds, but the clouds floated off into space. **Would things on the Earth change? In what ways would things change?**

The stories might be written or dictated for a class "Science Fiction" storybook and then illustrated with original drawings.

Through Key Concept Words. Introduce the term *water cycle*, and explain its meaning with reference to the review.

Through Investigation. If the day is warm and fairly humid, children can see droplets and drops form on the outside of a ice-filled glass or tin can. The water vapor in the air loses heat as it touches the cold surface. As it loses heat, the water vapor changes from gas to liquid. Children do not seem to tire of this basic investigation.

STORIES FOR A NEW VIEW

CONCEPTUAL SCHEME
The universe, and its component bodies, is constantly changing.

STORY 4, pages 150 and 151

CONCEPT

The Sun is our main source of energy.

Energy from the Sun produces changes on Earth.

Aim of the Lesson

To present, by means of a make-believe story, a review of the Earth's dependence on energy from the Sun.

Introducing the Story

REQUIRED: a globe of the Earth and a flashlight that throws a broad beam of light.

Begin today's review lesson with two questions for discussion:

Is the Sun shining today?

Was the Sun shining last night when you were asleep?

In daily speech, people frequently say on a cloudy day, "The Sun isn't shining today." Before today's story is begun, it is important to review children's understanding of day and night, sunlight and shadow. Through discussion and use of the globe and flashlight for demonstration, help children to realize that the Sun is *always* shining on the Earth.

Is it important for us that the Sun shines on our planet?

The Story

Invite the class to study the situation pictured at the top of the page. **Is this the way the Earth and Moon really look, or is this a make-believe scene?**

Through discussion, children will doubtless agree that the picture shows an imaginary situation. The Sun, Earth and Moon are not really dark as they are shown in the picture.

Next, read the title below the picture and call on someone to read the first three lines. Proceed with the remainder of the story, a line or two at a time.

As the story is read, you may wish to involve the class in discussion by presenting pertinent questions similar to the ones suggested below:

Would there be day and night on the Earth if the Sun did not shine? Why not?

Why would the Moon not shine?

Why would the Earth be cold?

Why would the Earth's water change to ice?

Would any of the water change to water vapor? Why not?

Would there be any clouds in the sky? Why not?

Would there be any rain? Why not?

Why could green plants not live? Can you think of three things that the plants could not get if the Earth were dark and frozen? (Light, water, and heat.)

Couldn't the animals keep alive by eating meat? Why not?

Assure children that this picture of the Earth as a dark, frozen planet is only a make-believe story. It tells us what the Earth would be like *IF* the Sun did not shine. The truth about the Earth is on the next page.

Proceed at once to the top of page 151, and read the first two lines aloud with emphasis. Choose several children to repeat the lines. Then continue with the story, a line or two at a time. To stimulate discussion, a few questions may be useful:

Who can use this flashlight and show us with the globe why we have sunlight every day?

How does the Moon get its light?

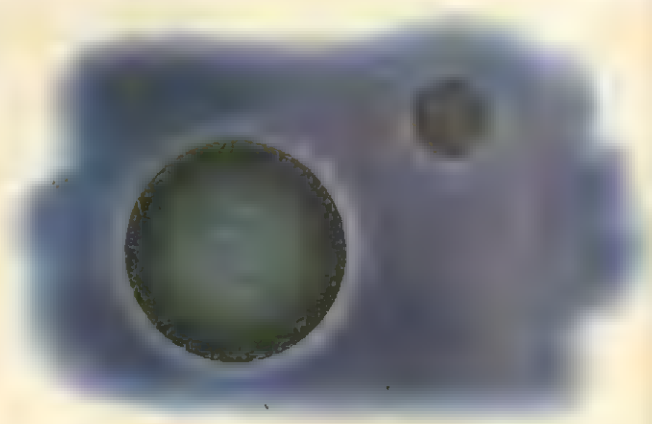
What does the Sun have to do with clouds and rain?

What are some of the foods that come from grass plants? (Breads and other cereal foods.) **From trees?** (Fruits and nuts.)

What foods do we get from animals that eat grass plants? (Dairy products, eggs, meats.)

Could *we* live on this planet if the Sun did not shine on it?

Conclude the lesson by referring the class to the picture at the bottom of page 151. Children might then take turns



What If?

What if the Sun stopped shining?
The Earth would have no sunlight.
We would have no moonlight.
Everything would be dark and cold.
All the water would change to ice.
Green plants would die.
Animals would have no food
if the Sun stopped shining.

describing ways in which each of the living things in the picture (plants as well as animals) is dependent on the Sun.

Extending the Concept

Through Art. Encourage children to draw or paint scenes showing some of the beautiful or interesting things that live and grow because the Sun shines on the Earth.

Through An Investigation. Let children use the globe, flashlight, and a tennis ball or orange to help them to recall, from Unit Six, page 59, how the Sun lights both the Earth and the Moon.

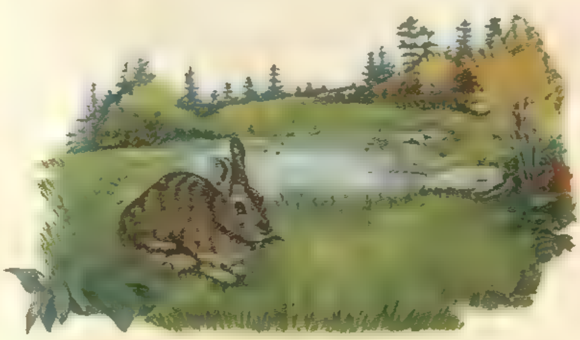
With Rapid Learners. Give the children a problem to think about over night:

In what ways could the Earth be different if it were *much* nearer to the Sun than it is? If it were *much* farther from the Sun?

The next morning, call on volunteers to discuss their assumptions. Suggest that children give reasons for the statements they make.

Some children may already know of planets that are nearer to the Sun (Venus and Mercury); and those that are farther away from the Sun (Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto). As far as we know, only Earth has all the conditions necessary to support life as we know it.

But the Sun does shine!
Because it does,
we have warm, sunny days.
We have moonlight at night.
We have clouds and rain.
We have grass and trees.
We have food from green plants.
We have many kinds of animals.
There is life on the Earth
because the Sun shines.



STORIES FOR A NEW VIEW

CONCEPTUAL SCHEMES

The universe, and its component bodies, is constantly changing.

Living things are products of their heredity and their environment.

Energy changes from one form to another; but the total amount of energy remains unchanged.

STORY 5, page 152

CONCEPTS

The Sun is the main source of our energy.

There is an interchange of matter and energy between living things and their environment.

Energy must be used to pull against the force of gravity.

Aim of the Lesson

To encourage children to use their imaginations as an aid to reasoning about conditions likely to exist on the surface of the Moon and thereby to reinforce their understanding of relationships existing on the Earth.

Introducing the Story

REQUIRED: plastic models of space men, available from most dime stores, toy shops, and from many drugstores.

Let children examine and discuss the models. Through discussion, review the fact that men in space suits explore places beyond the Earth, where conditions are different from those on our planet.

Announce that today's story is a "Just Imagine" story. It is a story about what could happen if *you* were a space child and went exploring.

The Story

Choose volunteers to describe in detail the situation shown at the top of the page. Ask, **"Why are you wearing a space suit?"**

Children's answers to these questions will reveal the information they have about conditions beyond the Earth.

Below are some facts you may wish to bring out:

The mask, helmet, hose, and oxygen (or "air") tank provide for breathing in space, where there is little or no air.

The heavy suit protects the space explorer from extreme heat or extreme cold.

Somewhere, the explorer carries food to eat and water to drink.

Next, read the title of the story. Then read the first four lines or choose a child to do so.

You may want to explain that as you come near the Moon, you are so far away from the Earth that Earth's gravity does not pull you down. *However, if you get near enough to the Moon, what does pull you down?* At this point, a word about gravity on the Moon may be appropriate.

Gravity on the Moon. You all know the pull of Earth's gravity. You can jump up, but you cannot jump very far away from the Earth. Gravity pulls you down before you get up very high. When you get on the scales, you measure the pull of Earth's gravity. Your weight shows how hard Earth's gravity pulls down on you.

There is gravity on the Moon, too. The Moon's gravity pulls things down, toward the center of the Moon. It is not nearly so strong a pull as Earth's gravity is. It is less strong because the Moon is much, much smaller than the Earth.

If you weigh 60 pounds here on Earth, you would weigh only about 10 pounds if you were standing on the Moon. Here you can jump a few feet into the air. On the Moon, you could easily jump twice as high as this room (about 24 feet).

In the story, Moon's gravity pulls you down. You stand on the Moon and look around. What do you see?

Choose someone to read the next three lines. After the questions have been read, encourage children to discuss the answers that are given, and to supply reasons for assumptions they make.

It is possible that some creative child will suggest that, since this is an imaginary story, the young explorer will find imaginary plants and animals on the Moon. If such a suggestion is made, you may find it worthwhile to take a few minutes to encourage some first grade science fiction. Let children invent some plants that do not need air or water. Imaginary animals, too, might be invented. They would have to be creatures that do not need air or water, and that eat something other than fresh green plants. If children show

Just Imagine

Just imagine that you take a trip.
You take a trip to the Moon.
When you get near the Moon,
gravity pulls you down.
Does the Sun shine on the Moon?
Is there any water or air?
Are there any plants or animals?
Soon men may land on the Moon.
Watch for it.

a lively interest in this sort of invention, it may be well to defer further discussion of make-believe life on the Moon until time for language and art.

Continue the lesson by asking how the young explorer can get off the Moon.

Conclude by asking what pulled the space child down to the Moon. What lifted him up, away from the Moon? Could they have left the Moon if there had been no energy to pull against Moon's gravity? How do space men leave the Earth, where gravity pulls down hard?

Extending the Concepts

Through Language and Art. If children are interested, give them opportunity to create their own space explorer stories and pictures.

Through Showing a Filmstrip. Show and discuss a filmstrip about space travel. For example: *Flight Into Space,* or *Man in Space,* both from Encyclopaedia Britannica Films, or *Rocket to the Moon,* Popular Science.

SCIENCE VOCABULARY CHART

WORDS USED IN CHILD'S TEXT

work, 15	Earth, 51	gold finch, 89
investigation, 25	light, 53	hatch, 90
magnet, 26	dark, 53	nest, 92
water, 30	shadow, 54	egg, 93
air, 30	Moon, 57	warbler, 93
rock, 30	plant, 62	cowbird, 93
solid, 31	seed, 62	leaves, 99
liquid, 31	grass, 70	*calf, 105
gas, 31	parent, 76	aquarium, 108
drop, 36	puppy, 86	whales, 110
cloud, 40	blue jay, 88	seals, 110
fog, 48	oriole, 88	penguins, 110
Sun, 50	sparrow, 88	elephant, 110
day, 50	robin, 89	tomato, 114
night, 50	mockingbird, 89	sprouted, 114

*optional

SCIENCE VOCABULARY CHART

WORDS INTRODUCED IN TEACHER'S EDITION

food, 2	melt, 32	grass, 70	cow, 83
energy, 2	heat, 33	fruit, 71	rabbit, 83
science, 3	thermometer, 33	tree, 72	pig, 83
electricity, 4	degree, 34	potato eye, 73	horse, 83
fuel, 5	temperature, 35	chicken, 76	sheep, 83
gasoline, 5	water vapor, 36	bird, 76	goat, 83
wind, 8	evaporate, 36	turtle, 77	mammal, 83
wheels, 11	droplet, 41	snake, 77	*colt, 83
friction, 12	fog, 42	lizard, 77	*lamb, 83
gears, 16	rain, 43	reptile, 77	*kid, 83
pulling, 17	Sun, 44	scales, 77	*sow, 83
pulley, 17	desert, 47	insect, 78	fur, 84-85
gravity, 21	rotates, 51	grasshopper, 78	zoo, 84-85
Earth, 21	space, 52	caterpillar, 79	gazelle, 84-85
force, 23	astronaut, 52	cocoon, 79	lion, 84-85
*weight, 23	*capsule, 52	moth, 79	bear, 84-85
*weigh, 23	reflect, 56	fish, 80	kangaroo, 84-85
lift, 24	flower, 62	salmon, 80	giraffe, 84-85
push, 25	seed pod, 62	gills, 80	zebra, 84-85
rocket, 25	sprout, 63	tadpole, 81	dog, 86-87
opposite, 25	soil, 64	frog, 81	cat, 86-87
metal, 26	roots, 66	lungs, 81	kitten, 86-87
iron, 26	stem, 66	*toads, 81	dachshund, 113
steel, 26	leaves, 66	*salamanders, 81	great Dane, 113
ice, 32	mold, 68	*amphibians, 81	weeds, 115

*optional

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